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VIEWS, NEWS AND INTERVIEWS.

Central station men in cities who complain that they are not able to make large enough dividends while running their plants every night in the year, may be interested to hear of a little electric light station at a summer resort on the Long Island coast. This plant operates about 800 incandescent lights and 50 arc lights through a season lasting but nine weeks; the remainder of the year the plant is shut down and closed up. The price charged for incandescent lights is 10 cents per night for each 16 candles of light, current being shut off at 1 A. M. One customer's bill amounts to $150 per month. Bills are rendered and collected at the end of every week. The bill for the last week of the season is collected in advance. The plant is well managed, of necessity. One storekeeper, when requested to renew his contract, was asked how many lights he had.

"Twenty-er-eighteen, I mean," said he.

"Your old contract is for 17."

"Well, there's 18 lights."

A contract was made out for 18 lights, but the superintendent, at the first opportunity, took a census of the place and discovered 20 lights in good working order. The new contract was made to read like the old one, for 17 lights, and three dead lights were entered. When the superintendent happened to be conveniently short of sockets he sent around for the three dead ones in this store. Rather than have them taken out the proprietor signed a new contract for 20 lights. He had had but 17 the season before, but, during the Winter these had mysteriously increased to 20. In spite of everything, this plant runs but nine weeks in the year and pays good dividends on the investment.

Ladies have complained that the incandescent lights in ball and supper rooms reveal defects of complexion and feature not observable under other light. This may be obviated by covering the incandescent lamps with pale yellow silk, when quite the opposite effect will be noticed.

The Crystal Palace Electrical Exhibition will be closed on Saturday, July 2.

Many graduates of our technical colleges remember Mr. Dudley's dynagraph car as it was explained to them by their professors. The car will soon start from the Grand Central station, in New York, on its annual spring inspection trip over the New York Central. This car is the invention and property of P. H. Dudley, and it makes semi-annual trips over three or four Eastern railroads to ascertain and record on paper the exact condition of the rails and roadbed. The car, which is 40 feet long, was built expressly for Mr. Dudley, and it is the home of himself and wife, as well as his workshop. It represents in its present state of efficiency the study and development of 20 years.

Mr. Dudley has perfected an ingenious electrical instrument, which, by a system of little glass tubes filled with ink and tapering to fine penlike points, will trace on paper, as the car moves along to any rate of speed, everything that is desirable to know about the condition of the roadbed. The paper used is about 24 inches wide and it passes from one roller to another, both the rollers moving in connection with the wheels of the car. A strip of this paper eight feet long is used to each mile traversed, and the points of the little glass tubes mark on the paper the alignment of each rail, the degree of curvature, as well as the elevation of each curve, the speed at which the car is moving and the condition of the surface of the rail. Every variation of one-sixteenth of an inch and over is recorded.

Connected with the registering and tracing instruments in the car is a contrivance which automatically ejects a drop of blue paint upon each joint in the track, where the end of one rail is one-sixteenth of an inch or more out of gear. At the end of the trip the exact number of such faulty spots is found recorded on a slip of paper. Trackmen are sent out on the various sections after the car has passed and the loose joints marked by the blue paint are properly adjusted.

Here is a sample of electrical news that is going the rounds of the daily press:

"Mrs. Edison prefers candles to any other form of household illumination."

Swinburne & Company's Exhibit at the Crystal Palace.

One of the most interesting exhibits at this exhibition is that of Messrs. Swinburne & Company, of Teddington, who show a number of "hedgehog" transformers, which are too well known to require any special description. The makers state that in designing closed circuit transformers engineers have neglected the loss of power in the iron, and that as this loss continues without intermission it is very serious. To prevent this they make transformers with a minimum of iron—a method which has a drawback—viz, the idle current taken on open circuit. Although the makers state that they have not found any trouble from this cause in central stations, they have foreseen that there may arise difficulties, and have therefore introduced commercial alternate-current condensers or compensators, which we shall describe separately.

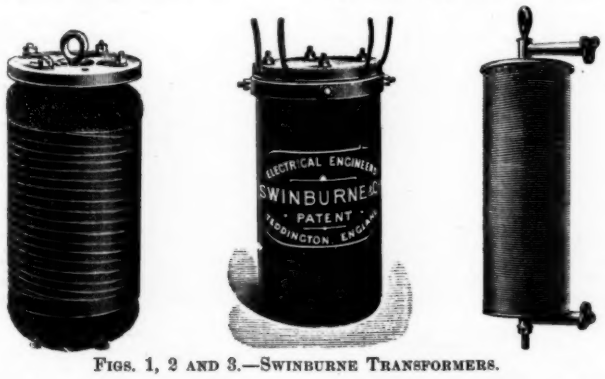
In addition to the ordinary transformer for house work, special designs for other purposes are shown. Two forms of street lighters are exhibited. One is the ordinary form with the stoneware case replaced by a light cover of roofing material. This is arranged to fix on posts for town lighting, as at Chelmsford, or to attach to walls, as usual in America. Each transformer feeds into a low-pressure circuit which supplies a number of lamps. This form is also used for arc lighting. In this case constant current transformers are used. These take 2,000 or 100 volts on the primary, and give 10 amperes on the secondary. The trouble and expense of secondary leads is entirely done away with. It is needless to say that an arc lamp will always burn more steadily on a constant current than under constant pressure, and this condition is more easily obtained with alternate than direct currents. In direct current work it is usual to run special arc circuits, or else to couple arc lamps in pairs in series with resistance. In alternate current systems, one high pressure parallel circuit supplies the whole current. For incandescent street lighting Messrs. Swinburne & Company exhibit a fitting which consists of a small transformer, with case, shade and lamp holder complete. This takes 2,000 or 1,000 volts, and has a 50 volt 32 candle-power lamp. The object of this arrangement is to admit of street lighting with incandescent lamps, without special secondary leads.

An interesting feature of this exhibit is a transformer, giving nominally 130,000 volts. It is uncertain how much higher this transformer can be run without breaking down. This high-pressure transformer is exhibited working on a condenser, and various experiments which the high pressure makes possible are performed. This kind of transformer has been, of course, designed for commercial use on cables. In order to test a cable of, say, 0.5 microfarads, under 50,000 volts, with a frequency of 100, a current of 12½ amperes must be available; 50,000 volts and 12.5 amperes need a 625 kilowatt dynamo. A large adjustable choking coil, however, takes or gives nearly the whole 12½ amperes. The dynamo and step-up transformer then supply quite a small current. Another way of accomplishing this is as follows: Suppose the dynamo gives 12.5 amperes and a few volts; one terminal of the dynamo circuit and the outside of the cable are then earthed or connected together. The other dynamo terminal is connected to the adjustable choking coil, which is in series with the inside of the cable. By this means 50,000 volts can be produced on the insulation of the cables. Messrs. Swinburne & Company are supplying a large testing plant of this kind to one of the leading cable makers, for testing a mile of cable at one time under high pressure. They also exhibit a low-pressure transformer, as employed in electric welding and similar work.

Several alternate-current condensers are shown. One of these is designed for 130,000 volts for performing experiments with the high pressure transformer. This condenser is for exhibition purposes, and is not for commercial use. The other condensers are designed to act as compensators, each supplying the idle current of transformers for 40,000 watts. These condensers are also useful for increasing the plant output when arc lamps are used, and it is proposed to use them to displace direct-current machines for exciting alternators. It will be a surprise to many to see how small commercial condensers really are.

Some new forms of instruments specially designed for central stations are also shown. These all have the same appearance, being made with solid brass cases and beveled glasses of the usual type. For high pressures, such as used in alternate stations, a special form of electrometer is made. The moving system has two almost semi-circular "needles," and the fixed system has four semi-circular boxes. The moving system works on tiny friction wheels, which make electric connection. The controlling force is gravity. The half disks of the moving system are cut in such a way as to give a very open scale between 1,800 and 2,200 volts. It is needless to remark that this form of instrument absorbs no power and has no temperature errors. Another instrument, which is much the same in external appearance, is a standard voltmeter for low pressure stations. This is a moving coil instrument. The moving system runs on friction wheels which make the necessary electric connection. The scale in this instrument is spread out for use in stations working between 100 and 110, or between 100 and 130 volts. The other instruments of this type are a station wattmeter for alternate currents, which takes 2,000 volts and 50 amperes, but reads

(Continued on page 231.)



FIGS. 1, 2 AND 3.—SWINBURNE TRANSFORMERS.

The Patent Electrical Deacon.

The past two or three years have prepared the public mind to expect almost anything of electricity, and there is scarcely a day passes that we do not hear of some new application of this force to lighten the labor or add to the comfort of mankind, says the Reading, Pa., *Herald*. Among the latest are electrical frying pans, electrical broilers and kettles, by which you can cook anything you want by simply pressing a button and without fire of any kind. Every cooking utensil, when it is to be used, is switched on to a portable wire and there you are. You take the current from the same main that furnishes power and light. Still another new application is the invention of the electrical church deacon, a device which goes around and takes up the collection in church quietly, noiselessly and efficiently, somewhat after the manner of the cash carriers employed in stores. It not only takes up the collection but counts it, and immediately announces the result on a dial placed in front of the pulpit. This will be a great saving to the deacon's legs; it will save time and will also save the risk of the deacon getting wrong in his accounts. The only improvement that can be suggested is one that will fire back at the contributors leaden coins that are sometimes dropped on the plate under the present methods of making collections.

Electricity and Its Relation to Transportation.

READ BEFORE THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF TELEGRAPH, JUNE 15, BY CHAS. SELDEN.

A subject so vast in its ramification and so great in its importance cannot have justice done it in a paper such as this shall prove to be, as it would take volumes to follow it in detail and mention even less than a majority of the master minds which have been instrumental in the progressive steps of advancement for the benefit of mankind; and the writer has only been impressed and imbued with the idea of attempting anything in this connection in the hope that the skimming of the surface may excite in the minds of others the deeper under-current of thought and research that may bring to light further beneficial ideas for the present and future generations and add to the lustrous glory of the electric past.

Pausing for a moment and mentally glancing backward, we are first charmed and then wondrous at the results of the past few years: and as we look to the future we stand spellbound at the enormous possibilities, making light of what has been and even now may be considered almost unattainable. In the electric field the long list of men honored by the result of their labors, and revered by those who are toiling ever forward, ever onward, should always be associated with the more modest artisan, who, by his faithfulness and knowledge of his work, made possible the achievement of the greater or more favored minds.

A revolution is not made in a day, nor are all the details of commercial success with the devices of the inventor his work alone; hence any of the decided advancements will

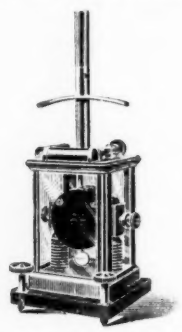


FIG. 4.—SWINBURNE GALVANOMETER.

be found to be due to an aggregation of mental power, mechanical skill and a free use of capital on at times an extremely slender chance of adequate return.

In 1843—not yet 50 years since—electricity, a promising infant, found itself a prodigy by first engaging commercially in transportation. Its tonnage was without weight in a materialistic sense, and consisted in transporting that wondrous intangible thing "thought" and though without physical weight, yet it disseminated throughout great distances the wishes, hopes, fears and joys of mankind. And in that year, upon the line of the now historic B. & O. Railroad, electricity made its first move in relation to transportation, and stood side by side with the other new baby, the steam engine, which had but shortly before displaced the sail cars and the horse as a mode of motive power.

In the transportation of "thought" and the word of command, cast about you now and pause for a moment, and one is almost breathless as he contemplates the living army, the thousands of vessels, the millions of wheels and the billions of capital which move and pulsate over land and sea governed through the infant prodigy. Springing into lively life and with elfish-like spirit, it threw its tiny sinews athwart the land away and in advance of the steamboat and railroad, over undeveloped new prairie lands and silent mountains of hidden wealth, to govern the movement of the great ox trains even to the spot upon which we now stand; and speeding beyond crossed the Rockies and bound the Pacific to the Atlantic shore. Resting but a brief space and not content, the infant who had thus far been largely in the hands of Morse, now joined hands with Field and, plunging into the Atlantic, brought the other continent into the bonds of commercial union and again demonstrated its relation to transportation.

With one or two exceptions, which I shall note further on, electricity rested content with the transmission of "thought" until, in 1861, Philip Reis, of Frankfurt, opened a new avenue and "sound" was transmitted from a distance hitherto unknown; sweet musical strains come from a modest little device fashioned with a knitting needle upon which was wrapped wire and the whole placed upon a slight sounding board, thus affording an instrument upon which the elfin infant played.

In the seventies, Bell, Edison, Dolbear, Hughes and many deserving others, opened still another avenue and "articulate speech" from distant points was the result; and today thousands of people are using, in this

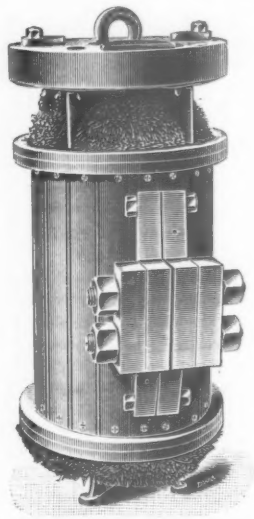


FIG. 5.—SWINBURNE TRANSFORMER.

form, electricity in its relation to transportation. Therefore, in this particular line, we find that from 1843 to 1876 the steps of the child had covered the enormous strides of transporting thought, sound, articulate speech. Such progress is stupendous in its results and marvelous, indeed, even to those who are closely acquainted with it.

But now, awakening, as it were, to a knowledge of its youthful power, see the young giant as he stretches his limbs and begins to yearn to try their lusty strength. He had before essayed this, in about 1832, through Thomas Davenport, a blacksmith, of Vermont; in '35 through Robert Davidson, of Scotland, and in '51 through Professor Page, of the Smithsonian Institute, the latter actually assisting to the extent of enabling the carriage by electricity of gross weight between Washington and Bladensburg; and somewhat strange, yet remarkably consistent, upon the same roadway where its infantile steps had left their first imprint. But the time was not yet ripe and the youth must sit content and wait and hope for the proper moment to arrive in which could be found the conditions necessary to success.

In 1864, while there was in progress the greatest warlike revolution known to history, there begun also one of the greatest revolutions known to peace, and Pacinnotti produced the avenue for which longingly our hero youth had waited, and later, seconded ably by Wheatstone, Gramme, Siemens, Brush and others, he demonstrated once more his relation to transportation by the transmission of light, heat and *power*. Oh! the magic of that last word. At *last* the time had come and straightway began a course of training, and the sinews of our youth became obedient thereto, and he waxed stronger than ever. All hail to his preceptors and abettors, be they the high or the lowly, and to each and all of each degree, all honor.

The iron horse, that winner of many a race, stands panting on the track ready for the command to advance again upon the course, beside him stands a creature of more delicate mould, silent as the grave, yet in that very silence lies strength and speed that shall win the day; and when the race is over we can truthfully say of the locomotive, "Well done, thou good and faithful servant," enter now into thy well earned rest. But if this is true when in its youth, what shall we not see when in the full vigor of great manhood this child of energy stands? Will he be satisfied with earth alone, or shall he spring into that atmosphere where in fearful frolic he sometimes plays and, disdaining earth, cleave the blue ether with absolute air lines, and annihilating, as it were, space, time, distance and friction, open up another relation to transportation entirely clear of the grievous right of way and other problems which clog the wheels of progress and sap the strength of capital? Ah! who knows? Judging by the past, nothing seems impossible with this dutiful, flexible, untiring servant, ministering alike to the sick, the distressed, the scientific, the rich, the poor, in thousands of ways, and withal so obedient to the will of mankind upon whom he showers beneficence, comfort, peace and wealth, and rouses within the breasts of all who come in contact with him that awe and reverence for an even greater power, without which even so good a servant could not exist.

But says the practical transportation men: "Give me some figures. If you have not gotten far enough to do that, advance some argument upon which I can predicate something." And he is right in asking such a question and I will do what I can in my way to answer him.

The manager of a railroad, I do not care where it is located or through what territory it runs, who has not awakened to the fact that the days of large rates and small tonnage are things of the past, out-rivals old Rip Van Winkle. Steadily, but surely, capital seeking investment forces competition forward and takes chances that were not considered sane some years since, and in the race for tonnage and passenger traffic it has resolved itself to a simple question of wholesale business; in other words, the movement of an enormous tonnage, each ton of which pays in itself but a slight profit and, therefore, the necessity of an enormous aggregate of small profits to provide a fund sufficient to meet the betterments and maintenance of property and the payment of the fixed charges. You cannot get away from this even if you shut your eyes deliberately, and if you will search the records of the past, "he who runs may read." In the face of these facts you are confronted with another; labor is becoming daily more intelligent, more aggressive and hence more expensive, the greater reason, therefore, to keep your wheels in motion, to swell your aggregate earnings and reduce your expenses without reducing the cost of your labor, and making each car earn money by not lying idle, but keeping them in motion by the most economical method.

Eminent motive power people have told me that experience shows that, under the best conditions, the locomotive can only be utilized to the extent of 25 per cent. of its power, and 15 per cent. under unfavorable conditions which are met daily. There are several factors that bring this about; partial consumption of fuel under high speeds is one, loss of fuel through exhaust is another, lack of traction is another and so on. You build an enormous machine in order to secure certain traction effects, and you mine and handle and rehandle, and haul and rehaul millions of tons of coal, every movement of which means money; and added to that you get only a low per cent. efficiency of what you finally at great cost deliver to your fire-box. Assuming (and I have reason for the assumption being well grounded) that you can take the power out of your coal at the mine and after conversion, you transport, not the coal, but the resultant power and energy by means that are, so far as record shows, practically everlasting, and deliver to your motive device a high per cent. of your power, are you not operating at an immense saving? And will it not enable you to meet the requirements of low rates, large tonnage and high wages?

Again, where your road is so located as to enable you to utilize water power, there is still more inuring to your benefit. I know that owing to the sluggish response of the turbine to a sudden call for increased power, that in operating a number of speed trains it is not all that could be desired; but that will be remedied, and for slow freight movement I believe that it would fill the bill even now; if it does, so much the better; practical trial alone will demonstrate it, and can be made upon many roads that are located beside streams and following their courses, where thousands of horse-power energy is wasting in its passage to the sea.

Owing to the brief time the electric motor has been employed as a practical tonnage mover, an attempt to show its economies as against the locomotive is an arduous task and it is hard to believe how difficult it is to get figures in such a shape as to admit of proper comparisons being made. One reason is that the street railway companies figure on the number of passengers carried, regardless of distance, as all pay the same fare for either long or short haul, while the steam railroads figure on the number of miles each passenger is carried.

The electric motor has practically dealt exclusively, up to this writing, with the carrying of passengers. There are a few isolated cases in which a freight car or two have been utilized, and records show that in one instance a single car in one year carried 10,460 tons, but unfortunately the records do

FIG. 6.—SWINBURNE RESISTANCE BOX.

not show the mileage made by the car, nor its earnings, and hence we cannot reduce the figures to tons carried per mile and earnings. Another difference in the method of accounting is that the figures are based upon the earning and expense per car mile, instead of the ordinary method employed by steam railroads. I selected, as a fair comparison, a steam road that pays a dividend and upon which the earnings from passenger service exceeded the expenses about 25 per per cent., taxing the car mileage and reducing it to miie per car, likewise showing earnings per car mile and expenses per car mile.

In arriving at my figures some of them were necessarily arbitrary, but in such cases, the percentages, I think, may be considered fair, and in order to allow of proper estimates being made by others, who may deem my basis wrong, I here give the detail of charges as taken by me.

FIGS. 7, 8 AND 9.—SWINBURNE MEASURING INSTRUMENTS.

Charge passenger 100 *per cent. of* passenger agencies, commissions, repairs and renewals of passenger locomotives, repairs and renewals of passenger cars, wages of passenger enginemen, wages of passenger firemen, wages of passenger conductors, wages of passenger brakemen, wages of passenger train baggagemen, fuel, light, oil, tallow, waste and miscellaneous supplies for passenger trains, station baggagemasters, cleaning cars.

Charge 75 *per cent. of* advertising.

Charge 25 *per cent. of* salaries of officers

and clerks, general office expenses and supplies, insurance of buildings, expense of traffic associations, rents of buildings, yards and terminals, legal expenses, stationery and printing, maintenance of way and structures, shop machinery, light for shops and offices, fuel for shops, watchmen for shops, miscellaneous items for shops, extraordinary repairs and renewals caused by accident, engine house expenses, cleaning engines, crossing flagmen, watchmen and detectives, expense of telegraph, superintendents, agents and clerks, station fuel, light and oil for signals, miscellaneous supplies for stations.

Charge 10 per cent. of repairs and renewals of boats, tugs, floats, barges, wrecking, stock killed, fires, action of elements, injuries to persons, wages, fuel and supplies, barges, boats, tugs.

Charge on mileage basis—Fuel for locomotives, preparing same and filling tenders, water supply for locomotives, all other supplies for locomotives, switch tenders and yard crews.

The above charges to passenger service, 26 and ⅛ fraction per cent. of the entire operating expense.

The cars in daily service were 618, and the mileage made during the year 36,672,550 miles, or for each car 59,340 miles. The earning (including mail and express—a source of revenue the electric roads do not enjoy) were $7,078,147.64, or per car $11,453.31, or per car mile 19.30 cents.

The expenses, classified as above, were $4,552,992.84, or per car, $7,367.30, or per car mile 12.41 cents, a net earning per car mile of 6.89 cents. The mail and express included in the above earned over $1,100,000, or in the neighborhood of one-seventh of the whole.

From an average of a number of electric roads, good, bad and indifferent, I have found the earnings per car mile to be 30.31 cents per mile and expenses 11.10 cents per car mile, leaving a net of 19.21 cents per mile, or a net gain over the steam road of 12.32 cents per mile.

These figures seem to show that the average of electric roads earned much more per car mile than the steam roads, and at an expense of only 1.31 cents per car mile less than the steam road. This slight difference in expense looks somewhat discouraging, but it must be borne in mind that the electric road figures are an average of a number of roads compared against a dividend earner and a net passenger traffic. There are electric roads operating for 7.8 cents per car mile and earning 24 cents per car mile, a difference in their favor in both earnings and expenses that catches the eye at once. Again, the steam road enjoys cheap fuel as against the electric road's high priced fuel and water. A crew of five men to five car trains steam, as against 10 men to five electric cars, and a proportion of taxation is charged against electric and not against steam in the figures given, and there are other matters entering into the expenses of operation that do not enter into the maintenance of steam roads, such as street paving, per cent. of gross receipts, park tax, etc., hence, when we analyze we have no reason to complain, and I think we can safely assert the economy of electric motive power over steam, at least in certain localities and under certain conditions, and I believe in nearly, if not all.

The electric roads of recent date are not cheaply constructed affairs either. You will find girder rails running from 60 to 85 pounds per yard, giving a track that would enable them to use it for rapid travel as well as heavy tonnage.

In contrasting the two methods of transportation one should also remember that the electric roads, generally speaking, traverse thickly populated districts and carry a great number of people over a short mileage, while the steam railroad is scattered over a large extent of territory. Just whether this is in favor of one or the other (rate per mile being taken into consideration), I leave for some abler hand to determine, but I feel sure if you will take up some steam roads and analyze them, division by division, you will find where comparatively short mileage is covered by a large number of people, and hence the near approach to parallel comparison with the operation of electric power can be made with the view of, upon some portions of a road, largely increasing the net results from passenger traffic.

There is, apparently, good reason for the layman to suppose that the electric motor is very limited in its power, because he naturally views it from what he has seen it perform, and hence argues that the best foot has been put forward, but he was never more mistaken in his life. The electric motor introduction is a revolution, and like all revolutions it meets with many obstacles. The first thing capitalists interested in street railway traffic met it with was, "We shall have to throw away millions of dollars in car equipment we now own." What, then, was to be done? *Build a motor to fit the existing equipment*, and it was done. Restricted, therefore, to certain dimensions, certain space and certain weight, the electric motor must necessarily be restricted to certain power; but how is it in other instances? An electric motor of, say, 50 horse-power, may be arranged to actuate one set of drivers, and then duplicates of the same until the one combined motor may have 300 or 500 horse power, and hence we find ample power to draw trains, just as has heretofore been done with the locomotive, and, it is claimed, more economically.

We know it is now practicable, at slight increase in cost of motor, to so construct as to carry a train of several cars at an even less cost per car than by small motors; and the progress in the distribution of high electric pressure which can be translated, makes possible the acquiring of greater power at less relative cost than was heretofore deemed probable, and it will go right on in that line.

Electricity, in a commercial sense, has never retraced a single step and it will not do so now.

Let me ask the general managers whether there is not some piece of road that is now operated at a loss that could be operated at a profit by electricity? You have track, you have coal, you have power houses. Is there not some such territory on your own road?

Take suburban roads, or suburban points upon a through line, do you not strive and spend money to build up the locations? Do you not sometimes for years maintain a non-paying territory clearly on hope and speculation as to the future? Do you ever satisfy the commuter? Does not a percentage want the 11 o'clock train made 12 o'clock, and *vice versa*, and perhaps both? You meet this by saying you are doing the best you can and losing money at that? Now, then, how much quicker could you build up such a territory by more frequent and less expensive trains, and carry freight cars too, one by one, or two or three, and thus supply your local traffic; or if needs be steam must haul freight, let it be done on the same track, they will work right along together. But, say you, the question of "speed comes in." So it does, yet I think you will find that the suburban public would rather have 24 trains a day at 20 miles an hour than 12 trains at 40 miles an hour, and I do not intend here to beg the question of speed. When it comes to speed, *per se*, rotary motion is undeniably capable of it with less strain and wear and tear than the reciprocating.

We feel that you do not want to make any expensive, useless experiments. Now, to avoid that, suppose you have some such territory as named; without the expenditure of a dollar you can get estimates as to the cost of construction and maintenance and operation. This Association is talking to you because we are all proud of the roads we represent; we are proud of the fact that electricity as a motive power is now so rapidly advancing, and to the extent that we can aid the roads in saving money and bettering the service we shall be proud also. We are your loyal subordinates; your success is ours; electricity in its relation to transportation has never failed you yet. We and our loyal co-workers constitute your electric safeguard, with its train orders, its signals—block and otherwise—and you will doubtless recognize that, being in the confidential arm of your service, we feel as if we should call your attention to the great question of the day.

With singular appropriateness, and, perchance, strange coincidence, it falls to the lot of the same corporation that first bore the imprint of electricity in its relation to transportation to be the one upon which the great task is now thrown of demonstrating the power of the electric motor as a tonnage mover.

In the Baltimore and Ohio tunnel, at Baltimore, arrangements are now making for a demonstration which cannot fail to be of great moment to the transportation world. The question of expediency and comfort, rather than economy, prompted the trial of a motor, and so sanguine is such a corporation as the Thomson-Houston Company, that they have contracted to equip the tunnel in such manner that the electric motor shall be capable of a speed with passenger trains of 30 miles an hour, and freight trains at 15 miles an hour.

It is expected that three motors will be more than sufficient to move 200 trains per day, each freight train's maximum weight to be 1,200 tons, and the motors will encounter grades varying from 45 to 90 feet per mile. There is specified a draw-bar pull or pressure of 32,000 pounds.

The motors will be simplicity itself, the armatures being fastened directly to the axles and without gearing. Each driver can be operated singly, or they can be multiplied indefinitely and act in concert. The motors will be used in two capacities. Going down grade they will act as a brake, and going up as a motive power.

Upon entering the tunnel the locomotive furnace door will be thrown open and no steam used, the motor drawing or pushing the engine and train. This will avoid all smoke annoyance. In addition the tunnel will be whitened and lit brilliantly with electric incandescent lights. Trains will be protected by electric block signals, and the tunnel will be ventilated by electric fans; thus the great experiment will be surrounded by everything conducive to comfort, speed and safety that electricity affords, and I feel sure will be an undoubted success.

Awaiting the result of this experiment in Baltimore stands the Baltimore and Lehigh Railroad. Rather than expend money at the moment for further steam power, for use in its suburban work, they propose to await the outcome, and if the experiment be successful, then the Baltimore and Lehigh Railroad Company will employ electricity as the motive power for all its suburban trains.

Objections are raised to trolley system generally and the high cost of storage batteries has precluded the extensive use of that system, but brave brain of mankind will assault again and again, and tireless in its perseverance, will finally find the way. In this connection, and simply to show you the channels through which mentality is at work, I present in a rough way the idea of Mr. Elias Reis, of Baltimore, whereby he proposes to move cars by electricity without a storage battery, a trolley wire, or a slotted conduit, or a rail connection. Whether or not he will succeed, the future will show. I have been informed that arrangements have been made to try the idea practically upon a section of road.

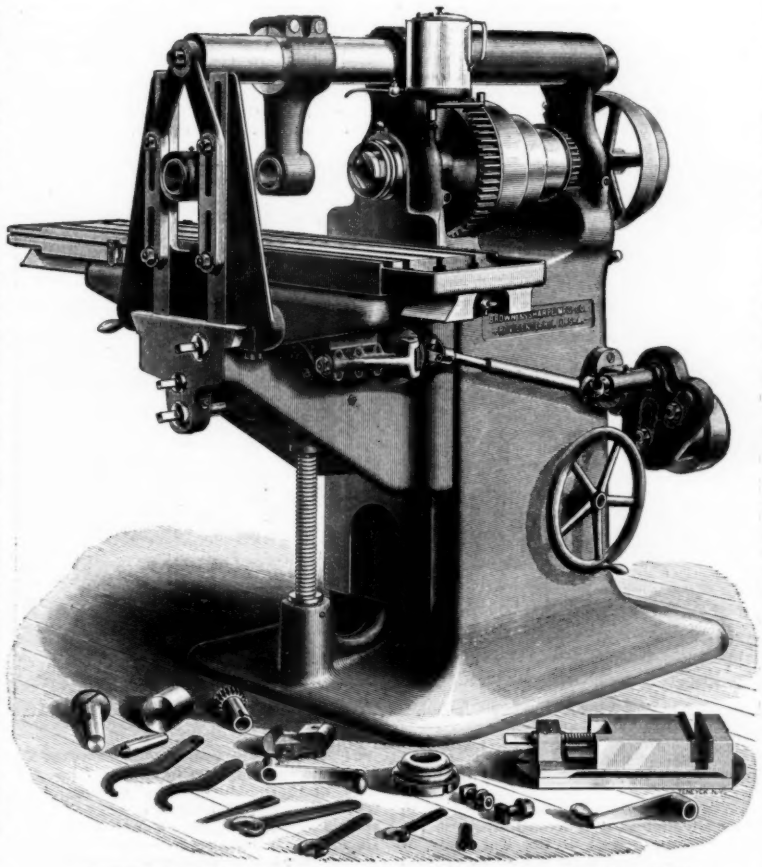
The method is the use of an alternating motor upon the car operated by induction. I have here an iron double trough casting having a central core. Traversing up one channel, lying against the core, and down the other channel, is a coil of wire. These castings are presumed to be 30 feet or of any desirable length, having a depth of, say, four inches, and a width of, say, six or eight inches, and the trough, as I term it for want of a better name, is flanged on each side for a width of, say, three or four inches. After the coil of wire is placed, you can fill around the coil with gum, paraffine, asphalt or cement. The terminals of the coil are to be connected to an underground sub-feeder carrying a current which has been transformed from a high to a low voltage. The high voltage wire is in a properly protected cable and carried underground. The troughs are placed in the center of the track and then paving, such as asphalt, is laid in contact with and over them from rail to rail, thus affording a smooth, unbroken roadway. The motor car has an exact counterpart trough suspended underneath the car and as close to the surface of the street as is practicable the terminals of its coil are connected to an alternating current motor, which in turn is so geared as to propel by its motion the car. It will thus be clearly seen that the true troughs and their component parts practically form a converter; one side of which is stationary and the other side moves with the car.

I have a small model car here with which to demonstrate the results obtained, and if I succeed in getting the current, I will perform some experiments for you, lighting glow lamps through asbestos, wood or glass, and then under the same conditions you will see the car propelled, although there is no physical electric connection between the car and the wires carrying the current from the power house. Paving, such as wood, asphalt or stone, will be permeated as easily as the glass and one may walk on the surface without feeling the slightest electrical effect. The same principle is involved here as is used daily in electric lighting by converters; and with this Mr. Reis expects to propel cars at a first cost as to plant, but little, if any, above the trolley system, and with an economy of operation that cannot now be obtained, thus offering to electricity still another channel in its relation to transportation.

You have borne patiently with a long and rambling paper, lacking in many things the essentials that it should have contained, but it is the best I could do, in a few hours snatched from a busy daily life, and with such meagre data as I found upon which to work.

I do not present the figures as absolutely correct, nor the charges or percentages either; but I do hope that I have done something that will cause others, whose abilities exceed mine, and whose time is more their own, to put their thinking caps on and prove for the benefit of all the economy or the non-economy of the electric motor as against the steam locomotive.

And where shall we stand in the bright future? The day of prophecy is passed, the promised era is here, electricity as a motive power is no longer a question or an experiment. During the past year it has carried millions of people, and during the next year it will transport millions of tons of gross weight; therefore, we owe it to our superior officers as well as to our subordinates, to be abreast of the times. Let us take our young inquiring men kindly by the hand. If they ask us questions we cannot answer, let us in turn be honest and tell them frankly that we are ignorant and ask them to give us the benefit of all they can learn; it will encourage them and help us both. When the inquiring mind comes to us with a radically wrong idea, deal gently, do not ridicule, but set it right as far as we are able. For aught we know there is a future Morse, Tyndal, Edison, Bell or Gramme before us, whose light shall shine when we are known no more. And finally take occasion (we are not yet too old) to devote some time, at least, to self improvement, and as we pass into the valley and retrospectively glance at the hill behind us, lit with the refulgent rays of our declining sun, there will surely be *some* recompense in the thought that, in our humble way, and to the extent possible, we have assisted in placing an imprint for *good* upon this great earth that shall go on after us, over progressing, over broadening, over benefiting future mankind until Time shall be no more and Eternity has come.



BROWN & SHARPE'S No. 8 PLAIN MILLING MACHINE.—(See Page 228.)

Brown & Sharpe's No. 8 Plain Milling Machine.

This machine, which has been put upon the market by the Brown & Sharpe Manufacturing Company, of Providence, is adapted for a larger and heavier class of milling than the No. 6, having wider cones for belts, larger spindle, heavier table and saddle and more powerful feed.

The spindle has a front bearing 3¾ inches diameter, 5½ inches in length, and a rear bearing 2½ inches diameter, 5 inches long. In addition to the taper hole for receiving the arbor, the spindle has a recess across the end and a cap nut, by which an arbor having a clutch collar is positively locked for driving the cutters.

The table is heavy, 66 inches long, 16 inches wide, having a working surface 54 inches long and a bearing in saddle 40 inches in length. It has three T slots running the entire length between the pans at end of same.

The overhead works have two sets of tight and loose pulleys 16 inches and 20 inches in diameter for 5 inch belt, and the countershaft should run 112 and 140 revolutions per minute. The weight of the machine, boxed ready for shipment, is about 5,000 pounds and the floor space occupied is 114½ by 68½ nches. (See illustration on page 227.)

The Connection of Steam Mains to Boilers.

We have discussed this subject on several occasions, but our experience and observation indicate that it will do no harm to say a little more yet, says *The Locomotive*. Where steam drums are used in connection with boilers set in battery, they are too often connected with the boilers by short cast iron or wrought iron necks, which make so rigid a connection that the least independent movement of one of the boilers is almost sure to start a leak or break something. The force exerted by expanding iron is tremendous, and the piping and connections of boilers should always be arranged in such a manner that slight movements of the boilers, from expansion and contraction, cannot give rise to severe strains at any point. Numerous accidents have happened from the use of too rigid steam connections, and accidents will continue to happen so long as such connections are used.

The accompanying engravings are from photographs of the boiler-room of a manufacturing company in New England. The boilers, settings and piping, were designed by the Hartford Steam Boiler Inspection and Insurance Company. The particular purpose that we have in mind in producing these engravings is to call attention to the manner in which the steam main is connected with the boilers. The steam main may be seen in the upper right hand corner of Fig. 1, back near the rear wall of the boiler-room; but it is more distinctly shown in Fig. 2. The center of the steam main is four feet ten inches above the upper surface of the boilers, and connection is made with it by means of risers and horizontal pipes, arranged as shown in Fig. 2. The length of each riser, in the clear, is about three feet six inches, from the nozzle to which it is attached to the angle valve at its upper end; and the horizontal pipe that runs from each of these valves to the steam main is seven feet long in the clear. There is no harm in making both the risers and the horizontal pipes longer than is here indicated, when there is sufficient room, but experience has shown in the boiler-room illustrated above, that the dimensions given are sufficient to provide for the slight movements that the boilers and piping have in the case under consideration.

These boilers are 66 inches in diameter, and have 72 tubes each, 18 feet long and 3½ inches in diameter. There are six in number, and, as shown in Fig. 1, they are set in a single battery. They supply steam for two large engines, for a bleachery and for two dye houses, one of which is 400 feet from the boiler-house. The drying machines consume about 150 horse-power, also, and steam is used for heating, pumping and other purposes. The main steam pipe is 12 inches in diameter.

It will be noticed that these boilers have no steam drum. We believe steam drums to be unnecessary in most cases where they are used, but we are aware that many experienced engineers claim them to be indispensable. If such drums are used, they should be connected to the boilers in the way the steam main shown in Fig. 2 is connected, with risers and horizontal pipes.

Fig. 3 gives a plan view of two boilers connected as explained above, except that in Fig. 3 the stop valves are placed in the horizontal pipe instead of at the top of the riser. We prefer the angle valves shown in Fig. 2, though the arrangement in Fig. 3 works satisfactorily. It will be noted that by a mistake of the engravers the valves *C C* in Fig 3 are shown with the stems *vertical* instead of *horizontal*. They should, of course, be horizontal, as otherwise the valves will trap water.

The Technical Education of the Electrical Engineer.

READ AT THE GENERAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, CHICAGO, ILL., JUNE 6–8, 1892, BY DUGALD C. JACKSON.

Perhaps it would be well to call my subject the "College Education of the Electrical Engineer," for it is strictly of the technical college course that I shall speak. We can truly affirm that the technical education of an engineer does not end until his work is ended, and the college course is but the commencement of it. That the college course can be made a very important fundamental part of this education is becoming more thoroughly appreciated as the work of the technical schools comes into closer harmony with the demands of the profession, and it is now generally agreed that a technical college course, of the proper kind forms a valuable aid towards the success of the average young man who wishes to enter the engineering professions. It, therefore, becomes a matter of no little moment to so arrange the course that its usefulness will be a maximum. A few years back, a college course entirely devoted to the training of electrical engineers was unknown. At the present time there is no dearth of such courses and their organization is progressing right and left, whence it is well to carefully consider what requirements of the electrical engineer's profession they may be made to meet, in order that no powder be wasted. It is neither possible nor desirable that the courses of study of electrical engineering students in the various schools should be alike, but a certain unity of purpose and treatment should be observed, and all can profit by the suggestions made by the practical man.

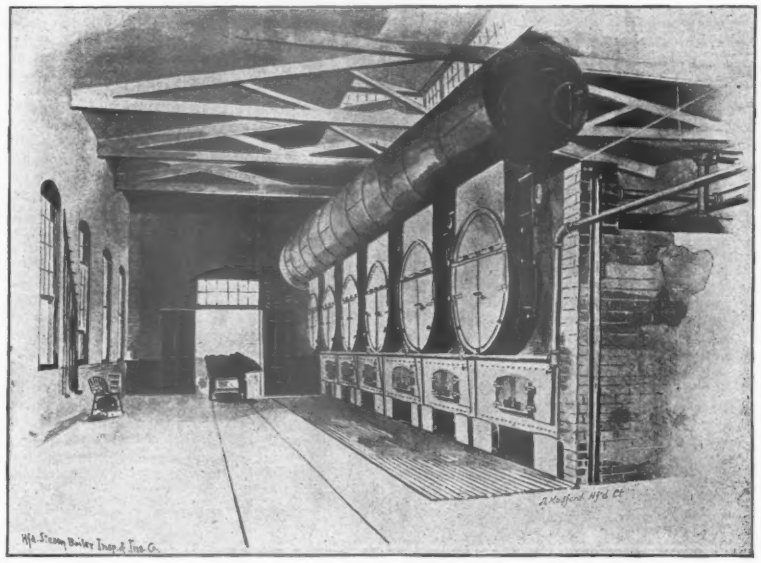


FIG. 1.—A MODEL BOILER ROOM.

With this in view, I present the subject to your attention as it is looked upon at the Engineering School of the University of Wisconsin. There is no originality claimed for the ideas presented, as they are based upon the recorded experience of some of the country's most successful practical men, and are virtually followed in such other engineering schools as make their courses thoroughly practical and, therefore, in the true sense, professional. I trust, however, that a discussion will arise that is in proportion to the wide importance of the subject to the electrical profession, and that must result in a considerable increase in the efficiency of the electrical engineering courses in our various colleges, nearly all of which are still in process of crystalization.

In order to enter the freshman class of the best engineering schools, the applicant must have a thorough common school education, including mathematics through ordinary algebra, a fair knowledge of English, a reading acquaintance with German or French, a little elementary physics and chemistry. This can be gained in the high schools of most of the cities of this country. The high school timber (some of it quite green) the college is required to work, and to work it to the best advantage requires no little careful designing. In order that an engineer may use his abilities and training most advantageously, he should have a good general education, including a fair knowledge of literature, history, economics and certain elements of law. This cannot be expected to come from the high school, and you can readily appreciate that an attempt to give a general education in an engineering course can only result in sacrificing the good of the students by omitting essential fundamentals. Thus, to have an average chance of proving successful, an electrical engineer must be well grounded in three sciences besides those gained in the common schools, and which cannot be classed as engineering. These are: Higher mathematics, as far as it may be practically applied in engineering; chemistry and physics (including elementary electricity and magnetism); and manual training. A few students enter college who have been given a fair start in these, but they are the exception, consequently, the subjects must be taught from the ground up, with a common sense view to their practical applications. Unlimited time could be given to these preparatory subjects, but it is necessary to clear them away in the actual time of two college years. With this requirement, it is impossible to give a very thorough knowledge of analytical chemistry, or of physics, but they are taught so as to give the student a good working knowledge and so that he can readily go deeper if he finds it to advantage in his future practical experience. The higher mathematics require all the time that can be afforded, especially in its last division, that of applied mechanics, where the student gets his systematic knowledge of the properties and uses of materials.

With the preparatory studies cleared away the student must enter into professional studies in earnest, but there is little time for true engineering. The developing electrical engineer must expand his physics and his chemistry and mathematics into the laws of electro-magnetism, alternating currents, electrolysis and electro-metallurgy, and study the conditions of their numerous practical applications in engineering and the arts, each of which may demand months of constant effort before an intelligent mastery is attained. Neither can he confine his attention to these during two full years, for he must gain an elementary but practical knowledge of thermo-dynamics and hydraulics, with an efficient working knowledge of their applications in steam and water power plants. He must also get a *common sense knowledge* of the principles underlying the design, manufacture and selection of machinery.

This is a great deal to expect a student to efficiently absorb in four years, and it requires a most judicious selection in order that nothing unessential be allowed to enter and that nothing essential be omitted. Let us see how the selection is made at the University of Wisconsin. The arrangement of the fundamentals will first claim our attention.

During the first year the student is given a course of four subjects, continuing through the year. These are: First, English and rhetoric, with such reference to technical forms as seems desirable so early in the course; second, mathematics, beginning with higher algebra, passing through trigonometry and descriptive geometry, and into analytical geometry; third, advanced French or German grammar and reader; fourth, manual training. In the latter, which continues during the following two years, we do not think it necessary or desirable for the student to spend sufficient time during his course to become a carpenter, machinist, blacksmith or foundryman. His future calling will probably not demand that his wages be earned in either of these trades, but they are tributary to his profession, and he must have an intelligent mastery of the tools and an appreciation of shop requirements. In order that some future day he may become a successful designer, or a useful shopman or superintendent, it may be desirable for him to take a properly arranged apprentice course in a first-class commercial shop, after completing his college course. Mathematics are also continued through the second and third year, during which time analytic geometry, calculus and applied mechanics are passed through. All mathematics are taught with especial view to future practical applications, and good use is made of the laboratory in applied mechanics. During the second year of the course, elementary chemistry and physics are disposed of, and here again the laboratory is put to good service. At the same time, work in draughting and the elementary designs of machines is begun. The third year is about half, and the fourth year wholly, devoted to what may properly be called professional studies. The arrangement of the latter in the electrical engineering course we will examine later.

Upon completing his technical college course of four years, an average student has spent at least 144 weeks of hard study, much of it of a practical workday nature. During this time he has been called upon to spend upward of five hours per day in classroom and laboratories, and about as much more time in individual study. No one is likely to go satisfactorily through such a course unless he has a decided taste for engineering work, but many students find themselves capable of doing a considerable amount of extra work, and yet have sufficient time for recreation to keep their health and spirits. It is well for an engineering course to stand beyond the reach of students without a taste for the work, for a successful engineer must be pre-eminently an enthusiast, while he is at the same time a candid and careful thinker. Those who are not fitted by nature to become engineers, are better placed in a general educational course at college, and they are then more likely to become useful to society and to themselves than if passed through the technical mill.

It may here be asked, Of what use is the severely specialized education to the successful student in the engineering courses? The graduate does not become an engineer merely because he has successfully met the college examination. College cannot make an engineer, however practical the course of study may be. Practice has made thousands of good ones without the aid of the college, but I venture to say that these would frequently have become more eminent if they had received a thorough technical college course. While theory alone, wherever learned, cannot make a practical man, it is the one who can follow the guide of theory along the paths of practical work and experience who makes the fully developed engineer. In order, however, that neither theory nor practice may lead him astray, he must have a well-educated common sense. The eminent and eloquent engineer, Alexander L. Holley, well illustrated this in one of his addresses when he said:

"Mere familiarity with steam engines is not, indeed, a cause of improved steam engineering, but it is a condition. The mechanical laws of heat were not developed in an engine house, yet without the mechanism which the knowledge derived through this familiarity has created and adapted, the study of heat would have been an ornamental rather than a useful pursuit. So in other departments. * * * When one in any art can make a diagnosis by looking the patient in the face rather than by reading about similar cases in books, then only may he hope to practically apply such improvements as theory may suggest, or to lead in those original investigations upon which successful theories shall be founded."

The true object of the technical college is here outlined. It is to teach the fundamental theories, with a common sense view to their practical applications, in such a way as to aid in a diagnosis, not by the application of a mathematical formula, but by comparing the accumulated experience of the practical world. Take two young men of equally good ability and equal age; put one through a thorough technical college course and the other through an apprenticeship of the same length of time. Finally, put them side by side in a working position, where they must work out their own salvation, and the college man will usually have more ambition and adaptability, and will outstrip his mate, though perhaps not at once. The college man may fall behind at first, but, having worked through the transition period, he will prove the winner. I venture to say this is the well-nigh universal experience of those who have had the opportunity of dispassionately trying the experiment.

Another illustration of the advantage of the technical college course lies with the designer. To design good machinery is a natural gift, and to become thoroughly successful requires long experience, in order that the widely varying requirements may each be given due weight. Proper instruction at the technical school may here do much towards stimulating an appreciation of the lessons of experience. The considerations of primary importance to be followed in designing machines are admirably divided by Prof. A. W. Smith into four: 1. Adaptability. 2. Strength and stiffness. 3. Economy. 4. Appearance. In developing the design of a machine, the practical, but highly sanguine, inventor often forgets all

the considerations except the first. A theoretical draughtsman may figure the strength to great precision by formulas that may not fully cover the required conditions, and in the meantime forget the other considerations. When the design reaches the shopman, it must be altered to suit his views of economy, as the prime factor. A machine is thus produced that has lost part of its adaptability as designed, and has neither sufficient stiffness to properly do its work, nor a thoroughly substantial, workmanlike appearance. The economical shopman has been defeated in his object, for the machine is hard to sell or requires costly repairs at the expense of the maker. A proper college course should sufficiently broaden a man so that he can quickly appreciate the demands of the prime considerations of practice, and will apply his formulas with common sense and moderation. If we replace our three men in the machine transaction by men of equal experience and a technical college education of the right sort, the work of each should supplement the work of the other, and the product can be predicted, with some confidence at least, to be a satisfactory commercial one. The fault of much of the college training for engineers has been the lack of this *education of the common sense* or judgment. The result has often been graduates with as great a contempt for the practical man as the latter could return. These graduates have, it is needless to say, been a failure in their calling, and it is such men that technical colleges should not turn out. The best engineering schools desire to, and do, turn out men who have a *capacity for practical* work and research, and who are in a fair way to make useful engineers.

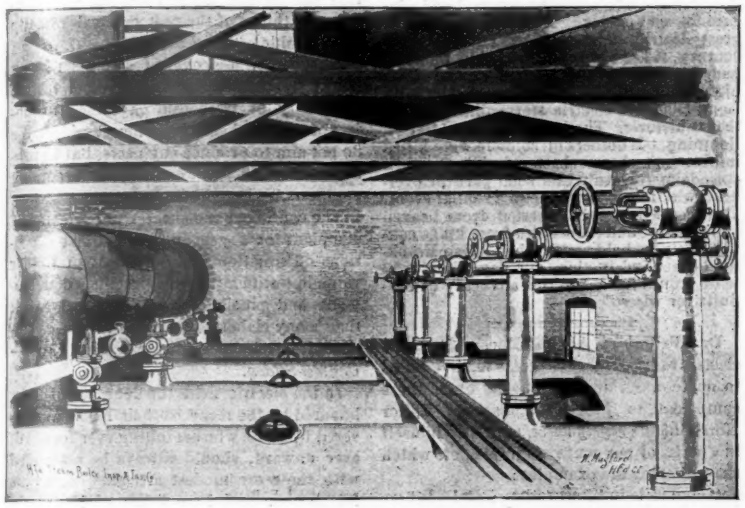


FIG. 2.—SHOWING CONNECTIONS TO STEAM MAIN.

It is comparatively easy to properly teach the fundamental theories, hence it is so frequently overdone. It is not so easy to educate the judgment of a student in electrical engineering whose entire knowledge of his future profession has been acquired from the electric bells in his father's house, and who may never have examined a dynamo or storage battery until he visited the college laboratories. But it is wonderful how rapidly such students, when of good timber, absorb a beginner's information and a thirst for investigation. In this part of the student's education the manufacturers and large users of electrical apparatus, who have become directly or indirectly interested in the work of the graduates, can assist with little direct inconvenience and much indirect advantage. In a properly organized technical school, as shown above, the student gains his fundamental theory during the first three years, and, if of good timber, he will absorb much of the practical methods of thought required for successful after-work. Moreover, a considerable part of the third year is spent in practical instruction. As the fourth year is wholly spent in practical training, or the education of the common sense, the student must have some acquaintance with the methods of commercial work before entering it, in order that he may properly profit by the instruction. It is impossible for many, and doubtless undesirable for the majority, to take a year from the midst of their college course for outside work. The summer vacation between the third and fourth year should, therefore, be occupied in some such employment as wireman on electric light or telephone construction, or better, in the station and repair room of an electric railway, under the eye of an appreciative superintendent. Three months spent in this work may seem very little, but it will do a deal of good in giving an apt student a fair idea of how far exact formulas will carry him. It is only by the generous co-operation of employers that students can obtain this summer's work. At first thought it appears that the employer gains no advantage from it, but, upon careful consideration, an advantage is evident. To begin with, the properly trained student will not prove useless during the summer, and the satisfactory one will usually find employment after graduation with the interests of those who afforded him summer work, and who thus gain the benefit of his greater advancement during his last year at college. In a similar manner, the manufacturer gains an advantage from placing his apparatus in the technical school laboratories for proper use in instruction.

Suppose a student has completed the prescribed college course, and has done a proper portion of repairing armatures, stringing wires, or similar work, at some interval between his terms at college, what shall we call him? A few of the technical colleges of the front rank call their graduates engineers, but we have already seen that they must pass through a transition period, during which the claim to the title can be proved. To call an untried graduate an engineer does not seem proper respect for him self or the successful workers in his profession. The transition period may never end for some graduates, while its length must always depend upon the man. Until the graduate has been in practical life a sufficient time to show his capacity, and has reached a position of responsibility, he has no right to claim from his college an engineer's degree. Upon this ground, the University of Wisconsin, as do many others, confers degrees in engineering upon graduates of its engineering school of not less than three years' standing, who have held engineering positions of trust for at least one year. The minimum transition period is thus tacitly recognized as three years. Upon completing his college course, the student is given a graduating degree of Bachelor of Science by the engineering school, which is simply an endorsement by the University that he has received a good technical college education and is in a fair way to profit by it.

That the rigid specialization required in the technical school may not diminish the graduate's field of vision and thus his usefulness to society, is a matter of much concern. With the college left behind, there is little opportunity to gain a broadening culture, except that received by contact with broad men, while we have seen how little opportunity for this can be afforded in the technical course. With this in view, we recommend, at the University of Wisconsin, that all who can afford the time and money complete a four-years' undergraduate course in the University School of Arts and Sciences before entering the School of Engineering. By proper elections during the general course, the studies of an engineering course can be completed in two additional years. By this plan a solid educational foundation is laid for the specialized studies of the engineering student, and the best conditions are developed for its ultimate success in professional work. The plan offers two other points of advantage: First, the student comes to his professional studies in the engineering courses with a more matured mind, which is of much importance; second, students without the taste for hard engineering work, which is required for their future success in technical industries, will not often attempt a technical course after having completed a general course.

We can now usefully inquire into the specialized work that should be prescribed for the average electrical engineering student during his last two years at college. Up to this point, students in mechanical and electrical engineering courses have received virtually the same instruction. Here, we hold, with several others, their paths should diverge. The student of mechanical engineering goes into careful study of shop practice, designing and utilizing various types of machinery, and similar subjects. The electrical engineering student must receive a good working knowledge of the problems of the mechanical engineer, but he must, above all, be trained in the practical problems of electrical engineering. He, therefore, goes into a study of that which will aid most in making him truly an electrical engineer. His knowledge must all be based on mechanical laws, but he must be much more than one-tenth electrical.

Before reaching his truly professional studies, the student should gain, during his course in physics, a common sense grasp of the elementary notions of electricity and magnetism, and of the "all-pervading law of Ohm." The latter can be properly enforced in the laboratory by placing in the student's hands ordinary electrical instruments, such as bridges, galvanometers, amperemeters, voltmeters, etc. Before beginning his specialized work, the student's knowledge of Ohm's law and its common results should have become almost instinctive.

With due regard for his preparation, it seems best to arrange the professional studies for the average electrical engineering student in four divisions, thus:

First. Electro-magnetism and its application to practical uses, with special reference to dynamos and motors.

Second. Electro-chemistry (including primary and secondary batteries) and electro-metallurgy.

Third. Alternating currents and alternating current machinery, including dynamos, converters, condensers, etc.

Fourth. The special application of the preceding divisions in electric light, power, railway, mining and other types of plants.

The last division is allotted about twice the amount of time given to each of the others.

While higher mathematics is a useful aid in each of the divisions, its limitations as an agent must be carefully set forth in the class-room and laboratory. For the purpose of educating the judgment and fully defining the limitations of theories and mathematical deductions, the laboratory is indispensable. As much as one-half of the total time spent by the student under the direct instruction of the professors of electrical engineering, should be devoted to the laboratory. This work, moreover, should as far as possible deal with commercial instruments and machinery, and actually follow the methods of testing and research used in practice. Physics, chemistry, mechanics, steam engine, hydraulics, dynamos, electrolysis, alternating currents and other subjects, should all be properly represented by a commercial laboratory equipment, which is made useful in every-day instruction under the direction of a man who has had experience in similar commercial work. The laboratory method of educating the student is unfortunately too little developed in many of our engineering schools, but a strong movement has begun in most schools to increase it in efficiency and amount. At the University of Wisconsin we carry the laboratory instruction as a part of the required work in every subject in which it is possible.

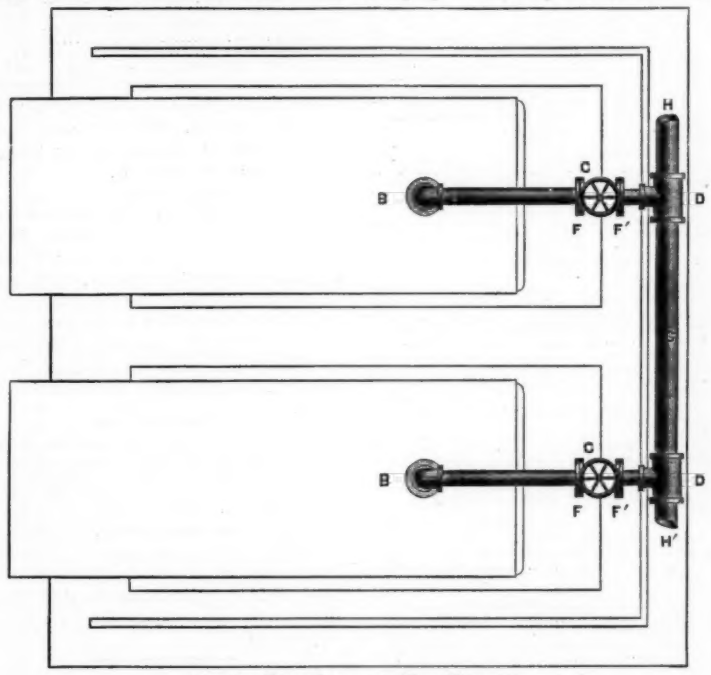


FIG. 3.—PLAN VIEW OF TWO BOILERS.

While the specialized course of the electrical engineering student during the last two years is largely devoted to strictly electrical engineering, he is also given proper classroom and laboratory instruction in useful allied subjects, such as the steam engine, boilers, water wheels, laws of contracts, etc., as has been already explained.

Students who are mature and show that they can usefully specialize more severely than is done in the regular prescribed course, are permitted, by election, to devote a greater proportion of their time to either of the first three divisions already enumerated. Thus a student may have reason to know that a thorough course in electro-metallurgy will be specially useful to him. In this case his work in the second division is increased beyond the course requirements, and his work in the first and third divisions is proportionately decreased. Other things being equal, a student who has thus arranged his course may graduate with his classmates who have followed the fixed course, as laid down. In the same way, a student of sufficient maturity, who feels assured of special advantages in the field of electric transmission of power or electric railways, may increase his work in the first or third divisions and proportionately decrease it in the second.

The student who satisfactorily completes a proper professional course at college, whether laid down in the college catalogue or carefully elected from that prescribed, is not likely to become one who "turns out results like a cornsheller, and never grows wiser or better, tho' it grinds a thousand bushels of them." In order that he may have a fair opportunity of growing "wiser and better" in the practice of his art, he should be given reasonable encouragement. As Mr. Holley one time said, an understanding should obtain "among the owners, directors, and commercial managers of engineering enterprises that it is not a matter of favor, but a matter of as much interest to themselves as to any class, that young men of suitable ability and of suitable preliminary culture, however acquired, should have an opportunity and encouragement to master the practical features of technical education in works, not as mere apprentices, but under reasonable facilities for economy of time and completeness of research."

A legend on the cover of a circular lately issued by the Engineering School of the University of Wisconsin, gave the true object of the technical college, when it says, "We do not aim to produce engineers, but to produce men with great capacity for becoming engineers." If our product is accorded the treatment advised by Mr. Holley (himself an experienced manufacturer), we feel sure the work of our school and of similar technical schools will not be useless.

The City Loses.

Judge Hunt, sitting in general term of the Superior Court, on June 7, rendered a decision in the case of Brush Electric Light Company *vs.* the City of Cincinnati. This was the case in which the plaintiff company sued to recover possession of $50,000 it deposited in 1889 as a guarantee that it would furnish the city electric lights at $59.40 per lamp per annum. The city now pays the Edison Company $83.90 per lamp. The court considered but one matter, and that was the board of alderman in postponing for an indefinite period the three readings of the ordinance for contract with the Brush Company refused the contract. And this, notwithstanding its subsequent action at special meetings. The order restraining the city from taking possession of the funds was made perpetual. The city will go to the Supreme Court with the case.

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This is the time of year to watch your lightning arresters. Electrical storms are beautiful natural phenomena, but burned out armatures are cold facts.

The New York Press Club has contracted for a site on which to erect a home. Four lots on William street, cornering on Frankfort and the Brooklyn bridge, have been secured for $247,000. The prevailing opinion is that these workers of the press have captured a bargain, and this community should strongly sustain the newspaper boys in their efforts to build a commodious club house.

The *Morning Advertiser* celebrated its first anniversary recently. It is a one-cent daily, edited by the able and experienced journalist, Col. John A. Cockerill, and has built up a circulation of 70,000. No brighter, cleaner, or more newsy paper is published in the metropolis, and the REVIEW takes pleasure in complimenting the *Advertiser's* editor on his success along the correct lines of journalism.

The ELECTRICAL REVIEW has always championed the inventor, and insisted that better facilities should be given to the Patent Office at Washington. The crowded condition there was illustrated and described at length in recent issues of the REVIEW. Our esteemed contemporary, the *Scientific American*, in last week's issue, endorses the position of the REVIEW, and presents a number of interesting views, showing the crowded condition in the various offices of the Patent Office. We welcome the assistance of our esteemed contemporary, and trust that these various influences will result in favorable Congressional action.

"Electricity and its Relations to Transportation," is the title chosen by Mr. Charles Selden for his address read before the railroad superintendents of telegraph. Mr. Selden's observations are couched in the enthusiastic phrases of a faithful and believing electrical worker, and his address is a brilliant *resume* of much that has been done besides forming a beacon pointing out to others the lines for further effort.

The New York *Evening Sun* recently dropped into the following editorial comments upon an electrical storm:

"The Newark thunder-storm is suggestive, if not instructive. Its grand flash, instead of seeking out a steeple to shatter, laid hold upon the wires of an electrical distribution system and burned out an assortment of armatures. But it also stripped off insulation, and so set fire to a church. This is extremely interesting to others beside insurance companies. If there has been a great electric storm in New York within a century, it has not found record in the ordinary historic chronicles. But on one of the nights preceding the British landing on Long Island an electric storm did come off that is historic. The heavens seemed to rain lightning. Numbers of soldiers were killed in bivouac and trees shattered. The Newark episode merely suggests what part the overhead wire might now take in a similar event. The gentleman who wrested from heaven its lightning and the sceptre from kings cannot justly be held responsible. Had Franklin been alive in this, our day, his sturdy sense would have led the advocacy of conduits for wires."

Dr. Wellington Adams' Chicago-St. Louis electric railway scheme seems to have failed to make a serious impression upon those competent to judge the matter. Editor North, of the *Safety Valve*, expresses himself in a series of pungent paragraphs, of which the following are examples:

"One mile in 36 seconds. Bah! Where is an electric road that is making the half of this speed, to wit, a mile a minute? or 50 miles an hour? or 40 miles an hour? or anything like it!

"Let this electrical genius who claims to be equal to the astonishing feat of producing 200 horse-power with a weight of 6,000 pounds in a motor going at 500 revolutions, build an electric motor that will make 50 miles an hour in actual every-day practice. When he has accomplished this, and we are sure that it can be done, though not at all sure that he could do it, he will be warranted in talking about still more speed. But for a man like this Adams, who has never accomplished anything original in motor practice, to talk seriously of perfecting a railway on which motors are to speed 250 miles in two and one-half hours on the overhead trolley system, it makes one search the horizon with something like anxiety to see if the fool-killer is not in sight."

RAPID TRANSIT PLANS.

David McClure, Robert Maclay and Benjamin Perkins, the commissioners appointed by the Supreme Court to consider the plan of rapid transit proposed by the New York Rapid Transit Commissioners, submitted their report to Judge Van Brunt on June 17. The commissioners, in general, approve the underground construction down town and the viaduct construction for portions of the road in less crowded districts and where the topography of the city renders it advisable. The motive power favored by the commissioners is electricity, and the uniform speed will be, in any case, for long distances, not less than 40 miles per hour, exclusive of stops. The commissioners believe that such a rapid transit system as is required can be operated electrically and that it is perfectly practicable. The health of passengers will not be injured, as proper ventilation of the tunnels can be provided. The commissioners think that the enormous amount of capital required will be forthcoming. The report of this latest commission is practically an approval of the plans of the original Rapid Transit Commission, which is a matter of congratulation for the gentlemen who composed it. They were William Steinway, John H. Starin, Samuel Spencer, John H. Inman and E. L. Bushe. The Supreme Court will pass on the report on June 29. This latest commission was appointed to consider the original plans and pass on their feasibility.

This is a step forward toward better rapid transit facilities for the city, and the tenor of the report just rendered is extremely gratifying to the advocates of electric power. There is no doubt as to the ability of electricity to perform its work in this instance.

SPARKS.

The following quotations are from addresses recently delivered before the American Institute of Electrical Engineers and the Association of Railway Superintendents of Telegraph:

From January, 1879, to December, 1891, 161 United States patents were granted for forms of telephonic selective signaling appliances.—*Thomas D. Lockwood.*

A proper college course should sufficiently broaden a man so that he can quickly appreciate the demands of the prime considerations of practice, and will apply his formulas with common sense and moderation.—*Dugald C. Jackson.*

The manager of a railroad, I do not care where it is located or through what territory it runs, who has not awakened to the fact that the days of large rates and small tonnage are things of the past outrivals old Rip Van Winkle.—*Charles Selden.*

A legend on the cover of a circular lately issued by the Engineering School of the University of Wisconsin gave the true object of technical colleges when it said, "We do not aim to produce engineers, but to produce men with great capacity for becoming engineers."—*Dugald C. Jackson.*

The continued and successful operation of one plant for a year under extreme conditions of situation and service is of higher value in testimony to the practical development and possibilities of electrical work than many elaborate projects for the operation of novel apparatus for a short time.—*Charles Selden.*

In the electric field the long list of men honored by the result of their labors and revered by those who are toiling ever forward, ever onward, should always be associated with the more modest artisan who, by his faithfulness and knowledge of his work, made possible the achievement of the greater or more favored minds.—*Charles Selden.*

In 1843, not yet 50 years since, electricity, a promising infant, found itself a prodigy by first engaging commercially in transportation. Its tonnage was without weight in a materialistic sense and consisted in transporting that wonderful intangible thing "thought," and though without physical weight yet it disseminated throughout great distances the wishes, hopes, fears and joys of mankind.—*Charles Selden.*

In the use of electric energy by motors operating under conditions of varying speed and torque the best results as regards economy and regulation are obtained when the electric energy utilized has a voltage varying directly as the speed and a current varying directly as the torque, for it is evident that under these conditions the electric energy required will be always proportional to the power developed.—*H. Ward Leonard.*

It may here be asked of what use is the severely specialized education and the successful student in the engineering courses. The graduate does not become an engineer merely because he has successfully met the college examination. The college cannot make an engineer, however practical the course of study may be. Practice has made thousands of good ones without the aid of the college, but I venture to say that these would frequently have become more eminent if they had received a thorough technical college course.—*Dugald C. Jackson.*

To be commercially successful, a selective signal for a telephone system must be of low cost, and in every form which has been put out and which has come under my observation, this requirement has been too prominently insisted upon, and the attempt has been made first of all to make not merely a low-priced, but a really cheap signal; excellency has not been insisted upon; in many instances the apparatus has been required to do too much, or to perform too many functions, and has, therefore, become complicated; and usually the places where such signals have been tried have also been places where intelligent supervision has been at a minimum.—*Thomas D. Lockwood.*

It is wise for electrical manufacturers to insure their employés against accident while in pursuit of their regular duties. The cost of such insurance would undoubtedly be returned by the increased faithfulness of the employés.

CORRESPONDENCE.

OUR BOSTON LETTER.

The **Worcester, Mass., Electric Light Company's** station is being taxed to its extreme capacity, lighting and power, respectively.

John Post Engineering Company has removed from 70 Kilby street, this city, to more extensive quarters at 180 Summer street.

Mr. Frank Waterman has been transferred from Westinghouse Electric Company's Pittsburgh office to the office of same company in this city.

The Waters Electrical Company, located for some months at Brockton, Mass., has leased pleasant offices and factory at No. 54 Lincoln street, this city.

The Edison Electric Illuminating Company, this city, has declared a semi annual dividend of three per cent., payable October 1, 1892, to stockholders of record September 23, 1892.

The Eastern Electrical Cable Company, this city, has declared a semi-annual preferred stock dividend of three per cent., payable June 27, 1892, to stock of record June 20, 1892.

Messrs. H. M. Kimball & Company, of this city, formerly of Messrs. Kimball & Slade, are the recipients of several nice contracts whereby to construct and equip electric street railways here in New England.

Mr. J. E. Byrne, formerly electrician of the Graves Elevator Company's eastern department, has been appointed general manager of the same concern's New England business, *vice* Mr. E. Marshall, resigned.

The Silver Lake Company, this city, are pleasing the New England Electric trade with a satisfactory solid braided cordage for hanging arc and incandescent lamps, trolley cords and for field magnets. Send for catalogue "R."

The H. E. Swift Manufacturing Company, well known manufacturers of arc and incandescent light supplies and a variety of electrical novelties and specialties, have removed from No. 34 Oliver street to No. 1 Hartford street, this city.

Wellesley, Mass., one of the most beautiful of Boston's lovely suburban towns and the world-renowned home of the great Wellesleyan Female Seminary, has appropriated $15,000 for electric lighting, and intends to own its own plant.

The General Electric Works, at Lynn, Mass., has received an order from Armour & Company, of Chicago, for two electric locomotives each of 15 horse-power capacity. These will presumably be used in the freight yards of the well known beef dressers.

Messrs. Claflin & Kimball, of this city, the New England agents of the Mather Electric Company, have recently closed several large contracts for installation of isolated incandescent lighting plants. Two of these were as follows: A 400 light 16 candle-power plant for Henry Smith, Lynn, Mass., and a 600 light 16 candle-power plant for D. McIntosh & Son, Holyoke, Mass.

Dedham's Electric Railway.—Advices of recent date from Dedham, Mass., state that the selectmen of this town, at their meeting this afternoon, voted to grant the petition of the Suburban Street Railway Company, of Boston, for a right of way through Dedham for an electric railway. The franchise is a conditional one, however, and, unless the company accepts the conditions imposed by the selectmen, will be void.

The West End Railway Company, this city, has announced as follows: A dividend has been declared of five per cent. on the common stock and four per cent. on the preferred stock of this company, payable July 1, 1892, at the office of the American Loan & Trust Company, 53 State street, to stockholders of record June 14, 1892. Transfer books will be closed from close of business June 14 to opening of business June 27, 1892.

Messrs. Swan & Lane have formed a partnership and established themselves in business at No. 194 Summer street, this city. They will make a specialty of installing isolated electric light plants, in which line the firm is thoroughly well posted. The senior member of the firm has personally superintended the installation of a number of isolated electric light plants in theatres, hotels and clubs, and his work has always given satisfaction.

The Walworth Manufacturing Company, this city, are experiencing a very satisfactory business in every department. Especially in the company's electric railway equipment factory are the manufacturing facilities heavily taxed. Among the orders received recently for poles and railway equipment were the following: For the New Orleans and Carrollton (La.) Railway, Mr. J. G. White, contractor, New York; for the Topeka (Kas.) Street Railway; Fitchburg (Mass.) Street Railroad; Rockland (Me.) Street Railroad, and the Natick (Mass.) Street Railroad.

The Jarvis Engineering Company, of this city, has refitted and beautified recently its offices and warerooms near the corner of Oliver and Franklin streets. The company has reason to be very much encouraged over its very satisfactory business during the entire winter, especially since the opening of the present year. Among the company's recent contracts was one closed with the Edison Illuminating Company, of Newport, R. I., whereby the Jarvis people will attend to the entire construction work connected with the new addition and furnish Armington & Sims engines aggregating 1,000 horse-power. The Jarvis Company has just closed a contract with the Worcester and Millbury Electric Railway for the erection and equipment of a power plant of 500 horse-power capacity. The equipment will comprise Armington & Sims' engines, Edison General Electric generators. Stuart & Son's tubular boilers set with Jarvis patent sitting.

W. I. B.

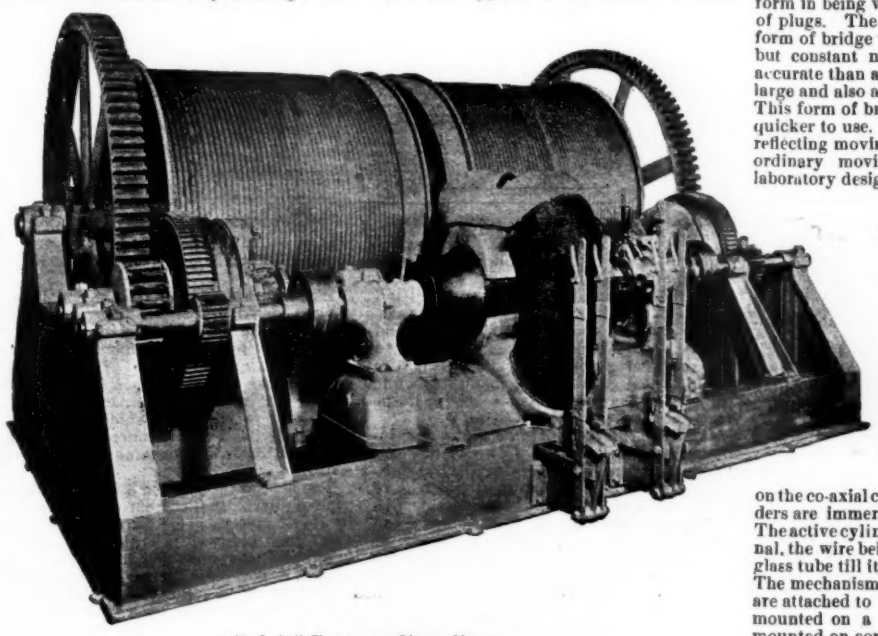
Boston, June 18.

OUR CHICAGO LETTER.

A New Electrical Monthly is to be started in Chicago in the course of four or five weeks. It is said that it will cater to the linemen rather than the engineers or experts.

The Central Electric Company report the call for the Interior Conduit and Insulation Company's goods, for which they are Western agents, as very great. Among the many new buildings in which they have placed their products is the new Germania Theatre building, on Madison street, and the Athletic Association building, on Michigan avenue.

W. C. McKinlock, of the Enterprise Electric Company, reports the first month's business of this firm as being largely beyond all expectation. They are rapidly stocking up their store and are carefully selecting a number of electrical specialties which they will soon place upon the market. It is predicted that this is but the beginning of what will be one of the many large electrical supply houses in this city.



"C. & C." Electric Mine Hoist.

W. R. Mason, manager of the Railway Equipment Company, reports orders received for the complete equipment of roads in New Haven, Conn., Brooklyn, N. Y., Baltimore, Md., and several places throughout the West during the past week, and the prospects for future trade very bright. The company is making arrangements to remove to their store in the Pullman building, fronting on Michigan avenue, which they have secured, and which will be fitted up in elegant style.

The Business of the Detroit Electrical Works still continues to grow and no prospects of a let-up, and among the many orders received recently is one from the Bell City Street Railway Company, Racine, Wis., calling for 14 equipments, also three 80,000 watt generators, together with overhead construction, etc. They are also in receipt of an order from the Calumet Street Railway Company, Chicago, for four 40 horse-power equipments, making the third order received from this company within the last four months.

The Electrical Storm which visited Chicago on Monday of this week was the most severe which has been experienced here in a long time. Many telegraph and telephone wires were blown down and much trouble has been experienced since by the telegraph and telephone companies, but they are rapidly getting the wires into shape again. The city at half past three in the afternoon grew very dark and the Chicago Edison Company were obliged to use the entire engine capacity of their station to supply the demand for light.

M. J. B.

Chicago, June 18, 1892.

Electric Locomotives—A Correction.

To the Editor of Electrical Review:

A passage in the newly published fourth edition of my "Dynamo-Electric Machinery" requires correction, being technically inaccurate. On page 616 the statement occurs that the electric locomotives of the South London Electric Railway are now being replaced by some of Messrs. Siemens' locomotives. In justice to Messrs. Mather & Platt, it ought to be stated that the 14 original locomotives supplied by them are still running, and that they have run in the aggregate not less than 450,000 miles. The two more recent locomotives supplied by Messrs. Siemens do not replace, but are supplementary to the original engines.

Silvanus P. Thompson.

London, June 1, 1892.

Our Printers Will Take an Outing.

The employés of the James Kempster Printing Company, 117 to 121 Liberty street, New York, will celebrate their sixth annual outing on Saturday, June 25, at Donnelly's, College Point, L. I. The men who do the excellent composition and press work of the Electrical Review deserve an outing and we hope they will enjoy it.

In Favor of the Stockholder.

A point of interest to stockholders in business corporations was decided June 17 by the Court of Appeals in the case of Thomas Commerford Martin *vs.* The W. J. Johnston Company, Limited. Mr. Martin had obtained from Judge Lawrence, of the Supreme Court, a peremptory writ of mandamus requiring the company to exhibit its books to him, and to allow him to make extracts or memoranda therefrom. The defendant company resisted the application, claiming that Mr. Martin was not a stockholder. The case was strenuously litigated and carried twice to the Court of Appeals. This court has now finally held, affirming the decision of the General Term, that the writ was properly issued and that Mr. Martin was entitled to the granting of the application as fully as it was allowed.

"C. & C." Electric Mine Hoist.

An electric mine hoist recently installed by the "C. & C." Electric Motor Company, in a mine at Corbin, Montana, is shown on this page. At a rope speed of 400 feet it lifts a weight of 5,000 pounds. There are two drums, each five feet in diameter by 40 inches long, intended to be run either separately or together, independently geared by two reductions to each end of the motor shaft. The motor pinions are rawhide. Their motion is transferred to the intermediate shafts by means of two Frisbie friction clutches.

The motor is 65 horse-power and is reversible. The reversing and speed regulating switch (not shown) is placed conveniently near the operator of the four levers shown. Two levers are for throwing the clutches in and out and two for applying the brake-band on the inner peripheries of the drums. The bearings have ample length and the whole machine is substantial and well made. It occupies a floor space of about 10x13 feet and has a total weight estimated at 16 tons.

SWINBURNE & COMPANY'S EXHIBIT AT THE CRYSTAL PALACE.

(*Continued from First Page.*)

in watts, and a station amperemeter for alternating or direct currents.

Among laboratory instruments this firm exhibits a non-inductive wattmeter. This instrument is specially designed to give accurate readings in such work as measuring power absorbed by iron in transformers. It is a dynamometer so designed that the self-induction errors are quite inappreciable. Another form of laboratory instrument for similar purposes is a direct reading electrostatic wattmeter. This instrument can be used either as a wattmeter or as a voltmeter. The particular instruments exhibited were made for some interesting researches on power measurements, on which Dr. Fleming has been engaged. The Bourne form of Thomson reflecting galvanometer is designed to fulfill special requirements. The moving system consists of two vertical needles, so that the instrument is truly astatic, and is not affected by external fields. The makers' object has been to make a really good instrument at a moderate price. The coils are well insulated, being embedded in ebonite, and are supported on corrugated ebonite pillars. The terminals are led through the glass sides of the case. The coils can be taken off and changed easily, and an exceedingly simple suspension is used, so that a new fibre can be put in with ease. This instrument has all the advantages of the Deprez instrument, combined with the extra sensitiveness of the Thomson.

Messrs. Swinburne also exhibit a resistance box which differs from the ordinary form in being worked by switches instead of plugs. The makers hold that the dial form of bridge with many coils and a small but constant number of contacts is more accurate than a plug with fewer coils and a large and also a varying number of contacts. This form of bridge box is, of course, much quicker to use. An object of interest is a reflecting moving coil galvanometer. The ordinary moving coil galvanometer is a laboratory design, and is a rather straggling instrument under a glass shade. Messrs. Swinburne's form is compactly arranged in a small brass case, and has automatic gear which grips the moving system when the galvanometer is lifted. A voltmeter is also shown for measuring currents up to 100,000 volts. A little consideration will show that it is not easy to design an instrument to measure a pressure with a striking distance of nearly a foot. This instrument is on the co-axial cylinder principle. The cylinders are immersed in heavy insulating oil. The active cylinder is connected to one terminal, the wire being carried up through a little glass tube till it is quite clear of the case. The mechanism and the other two cylinders are attached to the other terminal and are mounted on a glass plate, which is itself mounted on corrugated ebonite pillars. The striking and creeping distances are thus very great.

PERSONAL.

Prof. Sidney H. Short, of Cleveland, was at the Hotel Imperial Wednesday and Thursday of last week.

Mr. W. C. Bryant, the well-known switch manufacturer, of Bridgeport, Conn., enjoyed the heat with us last week.

Superintendent Morris W. Mead, of the Pittsburgh Bureau of Electricity, spent a few days in New York recently.

George B. Kerper, the well-known street railway man, has been elected a director of the Cincinnati Edison Electric Illuminating Company.

Dr. John McKinlock, of the Central Electric Company, Chicago, has recently been confined to his house by sickness, but is again at his desk.

General Manager C. P. Mackie, of the Electric Secret Service Company, New York, attended the convention of the Association of Railway Superintendents of Telegraph, at Denver.

Edison Wins.

At Trenton, N. J., the United States Circuit Court, on Monday of this week, decided in favor of the Edison Company in the suit brought by the United States Electric Lighting Company on the Weston incandescent lamp filament; granted October 21, 1884.

Telephonic News

*** Jeffersonville, Ind., telephone wires are to be put underground.

*** The Central Union Telephone Company objects to a recent decision assessing them 10 cents per connection where their lines run on the city's poles.

*** The Erie Telephone Company at its annual meeting in New York last week chose 21 directors and the same officers and executive committee as last year.

*** The Hudson River Telephone Company is building a metallic circuit from Albany to Newburgh, by way of Hudson to Catskill Station, crossing the river by cable to Catskill Point, thence through that village to Kingston and thence to Newburgh.

*** The directors of the American Bell Telephone Company have declared a regular quarterly dividend of three per cent., and an extra dividend of three per cent. payable June 15. Books close June 15 and re-open July 1. This is a reduction of three per cent. in the regular dividend.

*** The Southern Bell Telephone Company has removed its Richmond, Va., exchange from the Hanewinckel building to the northwest corner of Ninth and Main streets. The new switchboard has a capacity for 2,400 subscribers. The transfer was expeditiously made under the efficient direction of Superintendent C. E. McCluer.

*** At a recent meeting of the Luzerne Borough, Pa., council, an ordinance was passed allowing the New York and Pennsylvania Telephone Company additional privileges in that town, but limiting their monthly charge for an instrument to $4.50. It gave them the privilege of establishing a pay station and fixed the charge at 10 cents for five minutes conversation.

*** The authorities of the New England Telephone Company have suspected that there was something wrong in the service between this city and Boston, and secretly had detectives on duty in the vicinity. They tapped the metallic circuit at Jeremiah Smith's place at Smith's Ferry and carried the wires down the side of a tree and then into the house where they listened to decoy messages that were sent from Boston. A few days since Manager Messenger called and asked Mrs. Smith to tear down the wires running into the house. She refused and he said he would. She said it was a Boston man who put the wires up. Mr. Messenger found subsequently that some of the linemen were making a series of experiments, so no further trouble was made about it.—*Northampton, Mass., Journal.*

Manchester Electric Club.

The Manchester, N. H., Electric Club held a meeting at the Board of Trade rooms June 7, and, in accordance with the constitution and by-laws adopted at a previous meeting, proceeded to effect a permanent organization by the election of the following officers for the ensuing year: President, G. I. Hopkins; vice-president, J. Brodie Smith; secretary, Herbert W. Eastman; treasurer, E. J. Burnham; executive committee, G. I. Hopkins, *ex-officio*, chairman, E. M. Bryant, G. A. Corson, W. H. Fairchild.

The club starts off with the following charter members: J. Brodie Smith, E. M. Bryant, W. I. Leighton, George A. Corson, Arthur W. Ferrin, Bert Barlow, George D. Baxter, G. I. Hopkins, Scott E. Sanborn, Albert L. Clough, Harrison Corey, J. McInnis, A. N. Holbrook, Walter F. Buck, W. H. Fairchild, E. H. McQuade, Herbert W. Eastman, E. J. Burnham.

Long Distance Transmission for Lighting and Power.

READ AT THE GENERAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, CHICAGO, ILL., JUNE 6-8, 1892, BY CHARLES F. SCOTT.

The public interest in electrical subjects is continually sustained by the announcement of discoveries and projects which border upon the wonderful and extreme. In power transmission, one of the most inviting and promising fields, general expectation has been raised to commercial operation over great distances and at very high pressures. But many schemes which are readily planned with glowing outlines to accomplish wonderful results are defeated by difficulties encountered in details and unforeseen obstacles.

The test of practical operation has been applied in but few cases, and the severe test of continued operation over a considerable length of time is of rare occurrence. The latter test is one of great value and possesses a commercial significance which makes it of the highest importance. The continued and successful operation of one plant for a year, under extreme conditions of situation and service, is of higher value in testimony to the practical development and possibilities of electrical work than many elaborate projects, or the operation of novel apparatus for a short time.

It is with this idea in mind that a description is here to be given of two plants, one for lighting and the other for the transmission of power. The conditions which have been met include a very considerable distance, extreme difficulties of climate and roughness of country, exacting requirements in continuity of service, and a pressure above that ordinarily used in the class of machines employed. The plants to be described are the first of their type installed in this country, and the apparatus in the power plant is of a kind that has not been heretofore used. The type and construction of the machines, and the arrangement of apparatus are new in many particulars, and as they have contributed largely to successful operation they will be described with some minuteness. Alternating current machinery is employed, constructed by the Westinghouse Electric and Manufacturing Company, the pioneer company in alternating work in this country.

The lighting plant was first installed. It is operated by the Willamette Falls Electric Company, of Portland, Oregon. The general requirements are those which electrical transmission is admirably adapted to meet. Portland, a city marked for its prosperity and rapid industrial growth, has not the great advantage of proximity to developed coal fields, so that power, the fundamental requirement for industrial activity, cannot be obtained cheaply from this source. Another supply of energy, however, is found in rich abundance. The falls of the Willamette river at Oregon City, in the combined points of size, accessibility and nearness to the seaport, are unequaled. These falls, estimated at from 200,000 to 250,000 horse-power, are about 13 miles from Portland, and it requires but a moment's thought to appreciate the value of an agent which can make this power available in the city.

The Willamette river is about one-quarter of a mile wide, and the fall is about 40 feet. The present station is located on an island at the middle of the river. Victor wheels of 300 horse-power are geared to horizontal shafts, from which the dynamo belts pass to an upper floor at an angle of 45 degrees. Two alternating current dynamos for incandescent lighting are driven by each wheel. The current, at a pressure of 4,000 volts, passes directly to the line of No. 4 B. & S. wire, which is carried on ordinary double-petticoat glass insulators across the level country to a sub-station in Portland. The current is received at 3,300 volts by transformers in the sub-station and is reduced to 1,100 volts, for distribution by various circuits through the city to ordinary transformers, by which it is reduced to 50 or 100 volts.

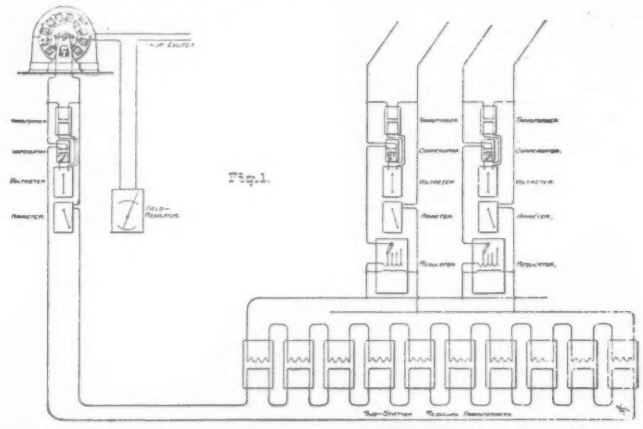


Fig. 1.

DIAGRAM OF APPARATUS AND CONNECTIONS OF LIGHTING PLANT AT PORTLAND.

When the apparatus was designed, it was not considered practicable to generate 4,000 volts with the ordinary type of machine, in which the wire is wound upon the surface of the armature, on account of the difficulty of insulating for more than 1,000 or 2,000 volts. The work was undertaken with a new type of armature, which is specially noteworthy, as it has rendered high potentials practicable in a machine of simple construction.

The field of the dynamo is of the ordinary type of alternating current machine in use in this country. The casting is circular in form, with 12 inwardly projecting poles of laminated iron, on which the field coils are placed. This type of machine combines simplicity with rigidity and strength, as both bearings and the lower field are in one casting.

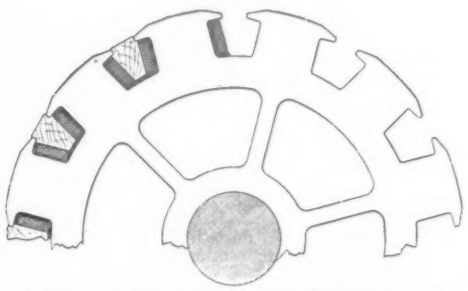
The armature is built up of laminated disks, which are punched with 12 T-shaped teeth. The armature coils are wound in a lathe, are carefully taped and insulated, and are then placed over the teeth and sprung in under the projections. The space between adjacent coils is filled by a block of wood, which holds them in place securely. This form of construction gives all the advantages of machine winding over hand work, allows ample insulation between coils and core, protects the coils from mechanical injury, holds them in position without the use of band wires, and makes the replacing of a damaged coil comparatively simple. The field current is supplied from a direct current machine, and the main current is taken from two collecting rings on the armature shaft. The reducing transformers are placed in a vault in the sub-station at the city. They are arranged in banks, or units of 10. Each bank is supplied by a separate dynamo, and has a capacity of 1,250 sixteen candle-power lights. The coils of the transformers are separately wound and taped, and are separated from one another and from the iron by strips of wood. The primaries are connected in series for receiving 3,300 volts, and the secondaries are in series for delivering 1,100 volts, so that there are 330 volts in the primary, and 110 volts in the secondary of each converter. This method of connection throws small differences of potential in any single coil and permits the use of conductors of good size. The necessity for special insulation is between the coils, where there is ample room for placing it. A transformer may be readily cut out of circuit by short circuiting its terminals, and in case of an accident in which a coil becomes short circuited, the electromotive force on that transformer disappears and the others are called upon to do a larger share of the total work, without interfering with service. The efficiency of the transformer at full load is 96 per cent.

The operation of the system is simple. The voltmeter or potential indicator is supplied by the secondary of a converter reducing in the ratio of 30 to 1. In the voltmeter circuit there is placed a compensator, which is a small transformer with its primary in series with the main circuit, and its secondary in series with the voltmeter circuit, and connected in such a way that the compensator pressure, which is proportional to the main current, is opposed to that of the converter. The compensator is so adjusted as to introduce into the voltmeter circuit a counter electromotive force proportional to the loss in the conductors, so that the voltmeter indicates the potential at the distant end of the line. The compensator effects the same result as pressure wires run from the point of supply back to the station. The electromotive force at the dynamo is adjusted for each load by regulating the field current so that the voltmeter shows the proper indication, thus keeping the pressure at the sub-station constant at 3,300 volts. The pressure at the dynamo is slightly in excess of this at light loads, and is increased to 4,000 volts at full load, to cover the loss of transmission. The secondary current from the reducing transformers is treated as if it were received directly from a dynamo. On each supply circuit from the station there is a voltmeter with a compensator set for the loss in this circuit. The exact adjustment of electromotive force on a circuit is made by a regulator, consisting of a transformer with its primary connected directly across the main terminals, and a secondary divided into small sections, each having an electromotive force equal to one per cent. of the primary. Any number of these sections may be placed in series with the supply circuit, thus varying the electromotive force at will. The form of regulator is of high efficiency, as it converts but a small percentage of the total energy, and the loss is a small fraction of this percentage.

The simplicity of the system, and the perfection of its operation, both from a theoretical and practical standpoint, are noteworthy. The electrical system receives mechanical energy, converts it into electrical energy, in a form suitable for transmission over a distance too great for other agents, and by the simplest form of conductor, and transforms it to a pressure suitable for commercial lighting. And yet, in the whole system, there is but one element in which there is mechanical motion, and that motion is simple revolution. The only wear and friction is in the dynamo, and its bearings are large and easily lubricated. The one point at which the high-tension conductors need be exposed is at the dynamo, where the brushes and fittings are of the simplest sort. The line does not deteriorate by carrying current, and as a piece of apparatus the transformer, in simplicity of construction and operation, is unrivaled.

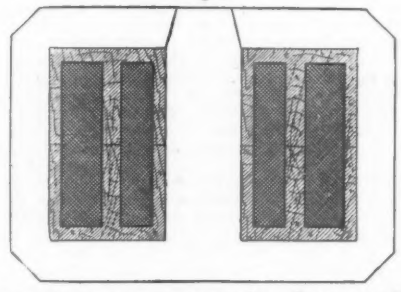
The plant was first installed with two incandescent machines and started nearly two years ago. Since that time five additional machines have been added, so that there are now seven, each with a capacity for supplying 1,250 sixteen candle-power lights in Portland. The total capacity is 8,750 lights. The dynamos run admirably. There was one night when several armature coils were

Fig. 2.



SECTION OF ARMATURE SHOWING IRON DISK WITH THREE COILS IN PLACE.

Fig. 3.



SECTION OF TRANSFORMER SHOWING IRON PLATE AND PRIMARY AND SECONDARY COILS SURROUNDED BY WOOD.

burned out, which was attributed to an iron wire falling across the main line and connecting several of the circuits, grounding them. Otherwise there have been no difficulties to speak of with regard to the operation of the machines. The superintendent of the plant states that the line has given very little trouble, much less than would ordinarily be expected from a city line. He also says that "the converters in the sub-station have not given one minute of trouble, and have not cost one cent for repairs." One explanation of the success of the plant is the intelligent policy of the general manager, in harmony with his statement that, "It is not the first cost which counts, but the cost of throwing out and replacing apparatus."

The same policy has happily governed the installation of the second plant to be described—the power plant. This is located near Telluride, Colorado, and is owned by Mr. L. L. Nunn. The Gold King mill requires power for operating its crushers and stamps, and fuel can come only from long distances at enormous costs. A few miles from the mill there is a water power, but the country between the two points is steep and rough, and for many months in the year is covered with snow. Electricity is the one means of getting the power from its source to the mill. The conditions are of the most favorable character for demonstrating the value and possibility of electrical transmission.

In this plant a Pelton wheel receiving water through a two-foot steel pipe, under a head of 320 feet, drives an alternating current generator. The current is carried over a line of bare wire to the mill, which is nearly three miles distant, and drives an alternating current synchronous motor of 100 horse-power. The generator and motor are machines of the same size and form of construction as the dynamos at Portland, already described, and differ from these only in some minor modifications.

The generator is provided with a composite field winding. A part of the magnets are excited by direct current from a separate machine, and the rest are excited by a current from the generator armature, which is proportional to the main current and is commutated by the equivalent of a two part commutator. The adjustment is such that the electromotive force on the main terminals rises as the current delivered by the machine increases, compensating for line losses and keeping the pressure at the motor 3,000 volts. The speed is 833 revolutions, giving 10,000 alternations per minute. The switchboard and regulating appliances are similar to those in the station at Portland. Ordinarily no adjustment is required after the machine is started, and the attendant has little to do besides looking after the mechanical running of the apparatus.

The motor is similar to the generator except in the manner of exciting the fields. The field current is obtained, not from a separate machine, but from a second winding parallel with the main coils around the teeth of the armature. This current is commutated and passes through the field coils. The motor, as already stated, runs in synchronism with the generator, and although the general theory of the synchronous motor is well known, it may be briefly outlined. If the terminals of two alternating current machines giving the same number of alternations per minute be connected together, and one be driven by an engine or other source of power, the second will run as a motor and will do work. The impulses of electromotive force which are generated in each machine occur simultaneously and are opposed in direction, so that only a small current flows through the circuit joining their armatures. As the motor is loaded, its armature is held back slightly and its impulses of electromotive force do not exactly oppose those of the generator. This causes an increased current to flow which prevents further change in the position of the motor armature and holds its speed in synchronism with that of the generator.

A motor of the synchronous type requires an auxiliary device for starting, which, in the present plant, is a small motor—a special modification of the Tesla type. This has a laminated field with inwardly projecting poles, on which coils are placed which receive current directly from the main circuit. The coils on the revolving armature are short-circuited. There is, of course, no commutator or collector, nor is there any exposed contact or auxiliary apparatus except the switch. This motor comes quickly to its normal speed and then has ample capacity for bringing the armature of the large motor up to speed. Both of the machines are belted to a countershaft, and the ratio of the pulleys is such that the speed of the large motor is a little greater than that of the generator. The large motor is then excited and runs as a self-exciting alternating current dynamo at the normal electromotive force of the circuit. The small motor is then switched off and the speed of the large machine gradually falls until it is approximately equal to that of the generator. The relation between the speeds of the two machines is indicated by the fluctuation in the intensity of lamps, which are connected in series with the secondaries of two converters, whose primaries are connected with the generator and motor respectively. When the electromotive forces of the two machines are in the same direction, current will pass through the lamps, and when they are opposed there will be no current. If the motor is running a little faster than the generator its electromotive force will be in the same direction as that of the generator at one moment, and will be opposed at the next moment, causing a corresponding variation in the intensity of the lights. At the time of slow variation and proper phase relation the machines are connected by closing the switch. The small motor is disconnected by its friction clutch and comes to rest, and the load is then thrown upon the large motor by a second clutch. The operation of starting requires but one man, and is accomplished in about two minutes. The rheostat in the field circuit is adjusted to give the proper field current as indicated by the ammeter. This is done when the motor is started and it may then run indefinitely with varying loads without requiring any adjustment whatever.

When the motor is running, the only things to be cared for are the brushes and the bearings. The high tension brushes—the only point besides the switches where the high tension is exposed—will run for a week without adjustment, the exciter brushes run without sparkling and the lubrication of the bearings is well provided for. The construction and operation of the motor is strikingly simple in comparison with the steam engine, which it replaces, with its many moving parts and intricate motions.

A few points illustrating the characteristics of the synchronous motor may be mentioned, as they are of both theoretical and practical interest. The connection of the motor to the generator is not a delicate operation. If the motor is running above synchronous speed at the time of connection with the generator it instantly adapts itself to the proper speed. If the motor speed is slightly lower than that of the generator it may fall into step when the switch is closed, but if it be running considerably slower it will not come into synchronism, but will further decrease in speed. When this occurs, the switch of the large motor is opened and that of the starting motor is closed, bringing the machine up to full speed again without any injury to the apparatus. If the electromotive force upon each of the machines before connecting them be 3,000 volts it will remain unchanged when they are connected. If the field current of either machine be increased the electromotive force will be raised, but the field current of the other machine may be lowered and the resulting electromotive force made equal to 3,000 volts. The current flowing between the machines depends upon the relative field charges, and is least, whatever the load may be, when the two machines are equally, or very near equally excited. The field current of either machine may be made zero, and the motor will still run, but with greatly reduced capacity. In a test with machines of a smaller size the electromotive force was 2,000 volts when the two field charges were equal. When the field charge of either machine was cut out it fell to 1,200 volts, and the current increased very considerably.

The explanation of the fact that the two machines may run together with widely differing field charges is easily understood when the extra flow of current at that time is taken into account. If the field charges are different the electromotive force tends to be different also, and a current flows between the generator and motor, which is of such phase that it tends to strengthen the weaker field and to weaken the stronger one. Thus, when the tooth of the motor is in front of a field pole, the current flowing at that time is in such direction as to weaken or strengthen the field as may be required to make the electromotive force equal to that of the generator. Difference of phase between electromotive force and current has an effect upon the regulation of a dynamo which is easily shown by changing the character of the load. If a dynamo, with a constant field charge, is used for carrying an ordinary load of incandescent lamps, a certain drop in electromotive force will result. But if the same current be delivered to an inductive resistance, such as a coil of wire, the starting motor, or a synchronous motor, when its

(Continued on page 234.)

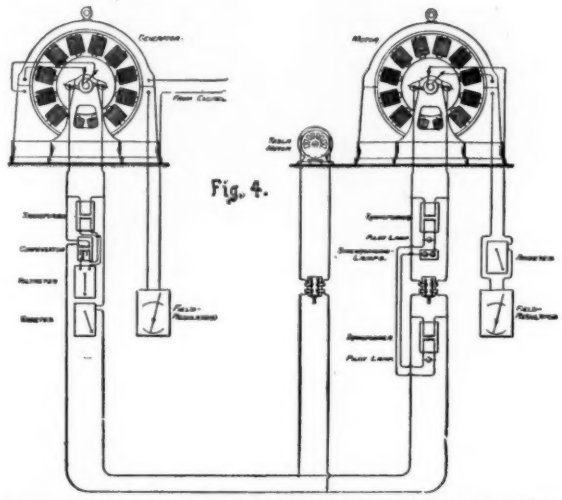


Fig. 4.

DIAGRAM OF APPARATUS AND CONNECTIONS OF SYNCHRONOUS MOTOR PLANT AT TELLURIDE.

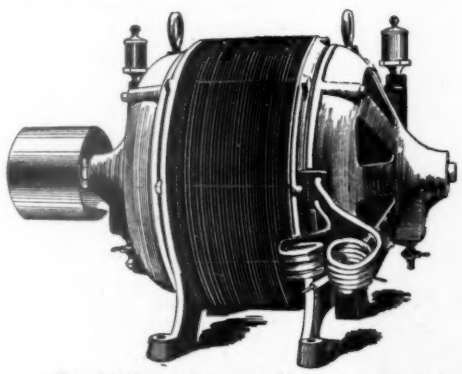


FIG. 6.—TESLA STARTING MOTOR.

Fig. 5.

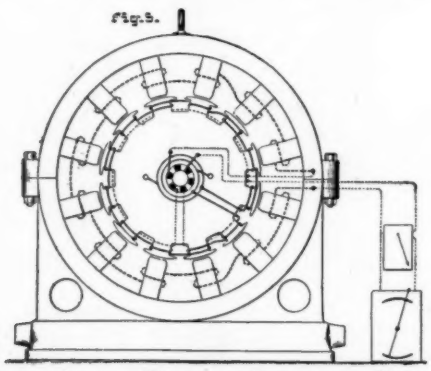


DIAGRAM SHOWING WINDING OF SYNCHRONOUS MOTOR.

TELEGRAPHIC

.... Plans are being prepared for the establishment of a system of military optical telegraphs round Paris, and trials are also shortly to be carried out with an improved apparatus of this kind.

.... Under an agreement between the Telegraphers' Association and the Pittsburgh and Western Railroad, operators under 18 years of age are not allowed to enter the service of the company, and the agreement is to be rigidly enforced.

.... The shareholders of the Mexican Telegraph Company and the Central and South American Telegraph Company, at No. 37 Wall street, have elected these directors: John E. Alexandre, Edmund L. Baylies, W. G. Hamilton, C. H. Marshall, J. Pierpont Morgan, Perry R. Pyne, Jr., W. E. Roosevelt and James A. Scrymser were chosen for the former company, and Edward D. Adams, George S. Bowdoin, W. R. Grace, W. G. Hamilton, Charles Lanier, J. Pierpont Morgan, José M. Munez, T. J. De Sabia and James A. Scrymser were elected for the latter.

.... The United States survey steamer "Thetis" arrived at Honolulu on May 20, from Hilo, where she ended the survey for the cable to be put in between San Francisco and the Hawaiian islands. The course to Hilo comprised 2,060 miles as surveyed by the "Thetis," with 300 soundings, against the survey of the "Albatross" of 2,150 miles and 250 soundings. The soundings were made at intervals of two, ten and sometimes one mile apart. The deepest was 3,228 fathoms, about 245 miles northeast of Hilo, and the shoalest was 976 fathoms, at a point about 350 miles from Point Conception. Were it not for this abrupt rise the course would have been almost level. The route traversed by the "Thetis" is considered by the officers as the most practicable yet surveyed.

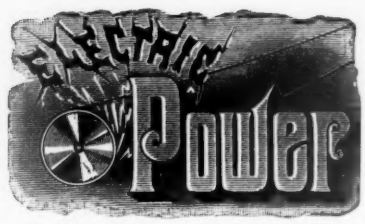
.... It is like a Munchausen tale at first glance, the statement that there were handled in Minneapolis since the Sunday night preceding the convention, that is, in 144 hours, over 8,000,000 words, says the Minneapolis *Journal*. And yet when the actual count is made this will not be far below the limit. Manager Maguire of the North American has made a careful estimate of the number of words sent out over the American's lines, 2,000,000 in specials and probably a million more by the United Press. Manager Cassidy says the amount handled by specials by the Western Union will be fully 3,000,000, and allowing 2,000,000 for the Associated Press, the Western Union handled 5,000,000 words. This, of course, is entirely outside of the commercial business.

OBITUARY.

Mr. E. V. Cavell, until lately general manager of the *Street Railway News*, died at Nassau, N. P., June 7. Mr. Cavell had been ill for some time and his death was not entirely unexpected.

Stockholders Apply for a Receiver.

John W. Hedenberg, James W. Hedenberg and Jason E. Prindle filed a bill in the Circuit Court, at Chicago, June 9, against Frank A. Smith, William H. Foulke, Samuel E. Nutting, Frank Foulke, Thomas S. Brown, Mrs. Nellie C. Bonner and the Nutting Electric Manufacturing Company to restrain the defendants from disposing of any of the assets of the corporation. Complainants are stockholders and claim that the defendants have entered into a conspiracy to close them out. It is claimed that the defendants are squandering the money of the company to lessen the value of the stock and the court is asked to appoint a receiver to protect the complainants. An injunction as prayed was granted by Judge Tuley.



* * Columbia and Marietta, Lancaster County, Pa., are to be connected with an electric railway.

* * The prospects for an electric railway between Syracuse and Liverpool, N. Y., are very flattering.

* * Surveyors are at work on the Providence Road laying out the electric railway between Chester and Media, Pa.

* * Lightning recently burned out two dynamos at the power house of the Rockford, Ill., Street Railway Company, and damaged their plant to the amount of $1,000.

* * A syndicate composed of northern capitalists has purchased the electric light and street railway plants at Tampa, Fla., which will be known as the Tampa Street Railway and Power Company.

* * A New Orleans despatch says the General Electric Company is buying up Southern street railway companies. The Atlanta roads have already been absorbed, and Mobile and New Orleans will soon follow.

* * The New York State Board of Railroad Commissioners has approved the application of the Port Richmond, S. I., and Prohibition Park Electric Railroad Company for permission to use the overhead single trolley electric system as the motive power on its road.

* * The Freeman-Holland Company, 518 Harrison avenue, Boston, has been unable to settle with its creditors on the basis proposed and John F. Buerkel and Samuel E. Bently, doing business as Buerkel & Co., have brought a creditor's petition in insolvency against the company.

* * The earnings of the West End Street Railway Company, Boston, are showing an increase of considerably over $1,000 per day, and it is expected that the increases will run between $1,000 and $2,000 per day for the months of June, July, August and September. It is not likely that Minister T. Jefferson Coolidge will resign as director until the annual election in November—if then.

* * The Brighton and Bensonhurst Electric Railroad Company was incorporated last week, with a capital of $250,000. This corporation is a reorganization of the Sea Beach and Brighton Railroad Company, which was purchased by Henry W. Slocum, William Marshall, Henry W. Slocum, Jr., and Denis Sullivan, under foreclosure sale. The road is located in the towns of New Utrecht and Gravesend, in Kings county, running from Locust Grove to Brighton Beach, L. I. The directors are Henry W. Slocum, William Marshall, William N. Dykman, Denis W. Sullivan, George Hoffman, Wyckoff Vanderhoof and George S. Jewell, of Brooklyn, and James C. Bergen and Henry W. Slocum, Jr., of New York.

* * Reading Railroad capitalists in Philadelphia and New York, by the purchase of $50,000 worth of treasury stock, in addition to friendly holdings, have secured a controlling interest in the Schuykill Electric Railway Company, whose lines now connect the boroughs of Pottsville, Yorkville, Port Carbon, Palo Alto and the popular Tumbling Run, Pa., summer resort. R. C. Luther, general superintendent of the Philadelphia and Reading Coal and Iron Company consummated the deal, and presumably is acting for the People's railway branch of the Reading Railroad, whose suburban business to Minersville and vicinity will be very materially interfered with by the Pennsylvania's new branch line. Extensions will be made by the Electric Railway Company immediately to Fish Bach, and the People's Line to Minersville is to be electrically equipped in order, it is said, to head off the Pennsylvania venture into that territory.

LONG DISTANCE TRANSMISSION FOR LIGHTING AND POWER.

(*Continued from page 233.*)

armature is at rest or its field is not charged, the drop in electromotive force will be considerably greater than with lamps. On the other hand, when the generator is supplying a synchronous motor running under normal conditions, the drop in one test was about half that which resulted from the same current to incandescent lamps. The current to the motor when running without load is quite small and increases in proportion as the load is added. With any definite load the

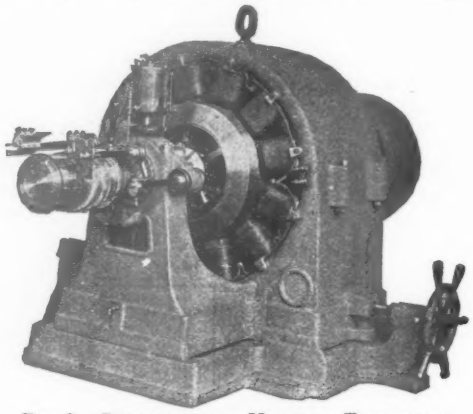


FIG. 7.—GENERATOR AND MOTOR AT TELLURIDE.

current between the machines, as already pointed out, depends upon the relative field charges of the machines as well as upon the electromotive force; but there is, however, a considerable range through which the field charges may be varied without materially affecting the current. If the load on the motor be increased to about twice its rated capacity it will fall out of synchronism and come to rest. The current, however, is held back by the self-induction of the motor armature and is not sufficient to cause immediate injury.

An efficiency test of the motor was made

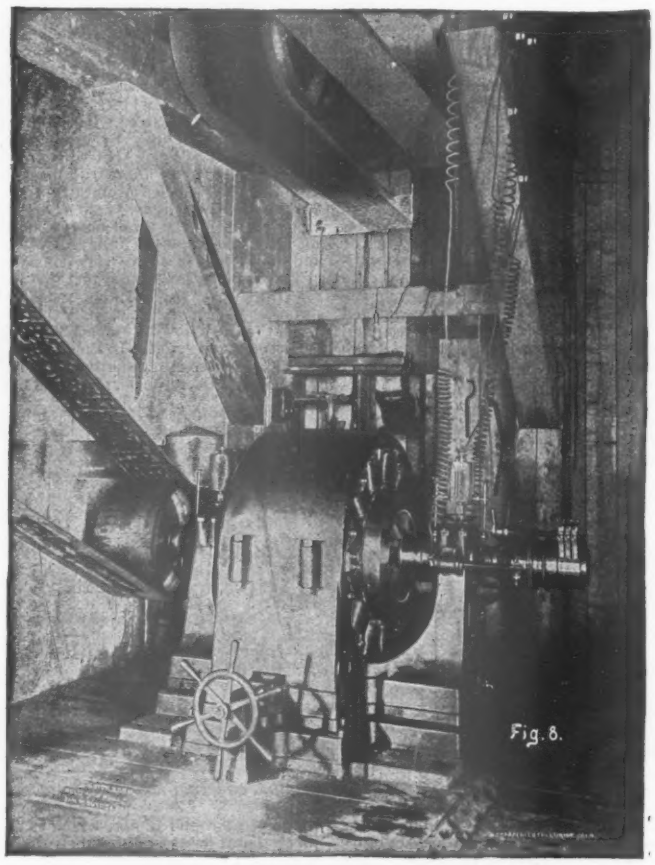


FIG. 8.—SYNCHRONOUS MOTOR IN THE GOLD KING MILL.

before shipment by driving a dynamo which was loaded. The current and electromotive force received by the motor and delivered by the dynamo were measured and an allowance made for the loss in the dynamo. The full load efficiency in this way was found to be 93 per cent. In a test upon smaller machines of similar type the efficiency of the motor at full load was found to be 91.5 per cent. The efficiency of the synchronous motor system, leaving out loss in conductors, but including losses in generator and motor, in the plant for delivery of 50 horse-power was found to be 83½ per cent. at full load and 74 per cent. at half load.

Full load may be thrown on the motor suddenly. In the Gold King mill the stamps, which are operated by the motor, are usually left raised when the plant is stopped, in order to avoid the extra strain of lifting them when the plant is started. It sometimes happens that the stamps are left down and the motor is required to raise them all at once. When the clutch is thrown in, the current indicates that the load is considerably above the normal capacity of the motor, and yet it is started without difficulty or apparent strain.

The excellent current regulation with different loads, the tendency of the machines to normal adjustment when there is ordinary variation in the field currents, the small liability to injury when the motor is greatly overloaded, the high efficiency and ease of attendance are points of great value in the practical operation of the system.

The pole line runs from the power station up the mountain to a height of 2,500 feet, and then crosses a rough but comparatively level country to the mill. The line at some places is at an angle of 45 degrees, and many of the poles had to be set in solid rock. The surface of the snow in winter is occasionally at a level with the tops of the poles, and parts of the pole line are practically inaccessible during some months of the year. This region is peculiarly subjected to lightning discharges, and special precautions are necessary to protect the apparatus. In one instance there were 42 discharges of the lightning arresters in as many minutes.

The plant was started for regular work in June of last year. An accurate record was kept from the middle of July to the first of May, showing the actual number and the length of the delays caused by electrical machinery. During these nine and a half months the system was in regular continuous operation six and a half days each week, with but few intermissions. The difficulties which were encountered were insignificant in amount and have resulted, not from any fundamental difficulty in the system, but have been caused by incidental defects or accidents which usually indicated their own remedy. The stops due to the electrical machinery resulted from a variety of causes and comprised the replacing of an armature coil damaged by lightning, renewing of fuses, fixing loose contacts, the examination of the line after a storm and sundry other slight mishaps. The aggregate time lost on account of the electrical apparatus was, by actual count, less than 48 hours during three-fourths of a year. A recent report from the superintendent of the plant covering the time from December 13 to May 1, shows that the plant was running 127 days with a loss of 19¾ hours, or as he puts it, an average of about nine minutes in a day of 24 hours. Although the plant was generally shut down each week for 12 hours on Sunday, this was not practicable during a part of the winter, and the motor on one occasion was run continuously for 27 days without any stop whatever.

Such a record as this, with a new type of machinery, in the country where line construction and maintenance are peculiarly difficult, with practically continuous service, with attendants who were not electricians, with a high voltage, a considerable distance and large power, places transmission by the alternating current synchronous system beyond the stage of experimental trial and give it the stamp of commercial success.

This success is confirmed in a substantial way by the immediate extension of the plant. A 50 horse-power motor is now being installed at a mill a few miles from the Gold King. An order has been entered for a 750 horse-power generator to be located in the power station, and a 250 horse-power motor for operating a mill about 10 miles distant. Lighting at Telluride, eight miles from the station, which has been heretofore done on a small scale on a circuit from the power generator is being extended.

The large generator is a new design, and is notable as it has more than three times the capacity of any alternating current dynamo previously made in this country. Two machines of this size have been running for some months for incandescent lighting in St. Louis.

This dynamo is of a type similar to the machines at Portland and Telluride. The field has 28 poles, requiring a speed of 570 revolutions for 16,000 alternations, the conditions of running at St. Louis, and 357 revolutions for 10,000, as it will be operated at Telluride. The armature has T-shaped teeth, as in smaller machines. The diameter of the armature is slightly over four feet and its length is about two feet. There is a third bearing at the end of the shaft outside of the pulley to relieve the other bearings from the severe strains resulting from belt tension. The total height of the machine is eight feet and its weight is 40,000 pounds. The electrical efficiency at full load is over 95 per cent.

The extension of alternating current working, both for lighting and power, by the use of larger machines is, therefore, already provided for.

The extension to greater distances is largely a question of electromotive force. Nearly every one is familiar with the rapidity with which the cost of copper diminishes as the voltage is increased.

If the cost be $100 with 500 volts it will be $25 at 1,000 volts, and $1 at 5,000 volts. The higher the tension, however, the greater the difficulty and cost of construction and the greater the liability to accident with apparatus and line. There are a few points in connection with this subject which may be noted without entering into a general consideration of it.

The smallest size of wire that can well be used for line work on account of its mechanical strength is about No. 6 B. & S. This wire will transmit with 20 per cent. loss 100 horse-power 10 miles at 4,000 volts, or twice the power at half the distance. Unless these distances or powers are to be exceeded an increase in pressure would result in no saving in copper but simply in a less line loss, which is already not excessive.

The use of 4,000 volts at the motor and a line loss of 20 per cent. requires an outlay for copper of only about 10 per cent. to 15 per cent. of the total cost of the plant when the distance is 10 miles. Unless, therefore, the cost of copper is to bear an insignificant proportion of the total cost it is unnecessary to exceed this pressure unless the distance be greater than about 10 miles.

These simple considerations show that pressures practically the same as those employed in the plants which have been described are ample for considerable distances. The same type of apparatus which has been successful in them is available for larger capacities. The fundamental elements required for electrical transmission in a very wide range of cases have, therefore, been tried and their success demonstrated.

For considerably longer distances, where pressures higher than about 5,000 volts are required, good practice indicates the use of transformers for raising the pressure at the

generator and reducing it at the motor, similar in general to those employed at Portland. The increased pressure thus available greatly reduces the cost of copper required, and this reduction must, of course, be more than sufficient to cover the cost of the transformers.

The prime requisite in a system for power transmission or distribution is simplicity. In this point electrical apparatus is scarcely to be compared with any other class of machinery. There is a marked difference, however, between the classes of electrical apparatus. In direct current machines the commutator is the characteristic feature. It is expensive to make, to maintain and to renew. The insulation of the armature is much more difficult, because it is necessary to connect a hundred points in the winding to exposed pieces. The commutator is the part requiring the most careful adjustment and attention both in construction and operation, and yet it is ordinarily the source of more difficulty than all other causes combined. It is, moreover, the principal element which limits the electromotive force at which this class of apparatus may be operated, and, in order to secure the advantages of a high electromotive force, systems are planned in which the generator and motor is each composed of three or four distinct machines to be run in series, thus avoiding an excessive electromotive force on any single commutator at the expense of many machines and multiplied parts. The alternating current machine substitutes for the commutator the simplest kind of contact, brushes sliding on plain rings.

The alternating current is anomalous. For years it has little place in literature and less in practice. Theoretically, it is intricate and complicated, and the earlier difficulties in its application caused it to give way to direct current. But the direct current is reaching its limitations in conditions which alternating current apparatus readily meets. The alternating current motor has been one of the most complicated and difficult electrical problems, and yet the first large alternating current motor installed in this country excels direct current apparatus in simplicity of construction and operation, in perfection of regulation, and handles with simple sliding contacts, running for a week without adjustments, a pressure which with commutators is impracticable.

There is another class of alternating current apparatus to which no reference has been made. The multiphase, or Tesla system, which has attracted much attention of late, possesses the characteristics of this type of apparatus, which readily adapt it for combining simple construction while the use of high pressures. There are also marked advantages in the characteristics of the motor which are of especial value where distribution of power is to be combined with transmission. Motors of this class are self-starting with load, and may be run either as synchronous motors or with one winding short-circuited and no commutator or brushes. The latter is the ideal motor in point of mechanical construction.

The simplicity and flexibility and range of the alternating current system make its possibilities the sole dependence of the largest enterprises toward which the public and engineers are looking. The records of the plants at both Portland and Telluride demonstrate that these possibilities are being realized and that work in this field is fast passing from experimental investigation into practical electrical engineering.

FIG. 9.—VIEW OF GOLD KING MILL SHOWING CHARACTER OF COUNTRY ACROSS WHICH POLE LINE IS RUN.

Human Electricity.

PROF. JOHN G. McKENDRICK IN LONDON "FORTNIGHTLY REVIEW."

The investigations of physicists make it highly probable that all movements of matter, even those of a molecular character, are linked with electrical phenomena. Our modern methods of producing electricity by friction, by induction, by heat, by chemical action, are but specially contrived imitations of processes carried on throughout the ages. Such considerations would naturally lead one to expect that electrical phenomena would also be associated with those finer molecular changes on which life depends, and that it is only a matter of experimental detail to demonstrate the existence of an animal electricity. It seldom, however, happens in science that we see far before us. When we look backwards, the light irradiates the way we have come, but pressing forward, we discover new facts only by stumbling on them.

All this is true of animal electricity. Electrical fishes have been known from very early times. But it was not until 1773 that Walsh first demonstrated that the shocks of the torpedo were truly electrical. Thirteen years later, Luigi Galvani noticed that the limbs of recently killed frogs became convulsed when brought near a frictional electric machine in action. This famous observation marks a new era in the history of science. All the world knows that the famous controversy between Galvini and his followers led to the invention of the voltaic pile in 1799, and still more to the discovery of the production of electric currents by the contact of dissimilar metals, more especially when one of them is acted on chemically by certain fluids. For a long time the brilliancy of the results flowing from the investigations into voltaic electricity threw the discoveries of Galvini into the shade; but, by and by, as experimental methods became more delicate, it was found that there is, in truth, an animal electricity, the existence of which was doubted by Volta and his followers.

The researches of Nobili, in 1825, showed that Galvani was right as to the existence of an animal electricity, but wrong in holding that the contact of two metals with the tissues afforded proof of it. Mattenci, about 1837, enriched the subject by many beautiful investigations, and by joining the thighs of frogs in a special way he made a living voltaic pile, which produced effects similar in character to the piles built up by physicians with disks of metal and intervening disks of paper or cloth. Then came Du Bois Raymond, whose researches have advanced the subject another and an important stage.

The existence of electrical phenomena in living structures is now demonstrable by means of a sensitive galvanometer, or the ingenious capillary electrometer invented by Lippman in 1873. By connecting tissues with the unpolarizable electrode of Du Bois Raymond it can be shown that all living tissues show differences of potential at different points, or, in other words, that electrical currents pass through the instruments when the tissues are placed on the electrodes. In the case of muscle, the strongest current is obtained when one electrode touches the center of a transverse section, while the other touches the uninjured surface of what may be called the equator of the muscle—that is, a line encircling it in the middle of its length; and it can be shown that the surface is always positive to the transverse section. But the case is different when the tissue or organ discharges its normal function. This will be readily understood if we examine what occurs in a contracting muscle. The normal function of a muscle is to contract. Now, suppose a muscle laid on the electrodes so that a "resting" current is manifested by the deflection of the needle of the galvanometer; let the nerve supplying the muscles be irritated so as to cause contraction of the muscle; instantly the needle of the galvanometer moves in the opposite direction, and may pass even beyond the zero point. This is due to the generation of a new current in the muscle, in a direction opposite to that of the resting current. The proof is this: Let us compensate the resting current before causing contraction of the muscle, by sending a portion of a current from a Daniell's element in the opposite direction so that the galvanometer is brought to zero; then cause the muscle to contract, and the new current, the action current as it may be called, sends the galvanometer needle to the opposite side of zero. This is a vital phenomenon, which can occur only when the muscle is alive.

Electrical phenomena may also be discovered in the central nervous organs. If we bring the electrodes of the galvanometer into contact with the surface of the brain, electrical changes occur when light falls on the eye. Recently Gotch and Horsley have explored the spinal cords with electrodes connected with the capillary electrometer and have found electrical variations in the motor strands of the cords, when motor centers in the cerebral cortex were irritated. Thus in a sense they tapped the wires of the living telegraphic system, and got information as to the paths in the cord along which motor, and even sensory, impulses travel. It seems to be only a matter of experiment to discover electrical changes in all the cerebral nervous organs. Could we picture to ourselves the changes in the brain when its higher centers are in a state of molecular disturbance, as when one is thinking rapidly in a lecture, now adapting his words to his ideas, now thinking ahead as to what he will say next, now noticing the effect of his words on the audience, now becoming conscious that he is obscure, and again that he is succeeding in making things plain, now watching the clock and noting the inevitable flight of time—could we, in such circumstances of mental turmoil, examine the phenomena of the brain, we would, in all probability, obtain evidence of rapid changes of potential, and of currents flashing in a thousand directions, pursuing paths more intricate than would all the telegraphic and telephonic wires in London, if they were concentrated in one vast exchange.

ELECTRIC LIGHT NEWS

—— The McKeesport, Pa., *Herald*, is advocating a municipal electric light plant.

—— The Citizens' Electric Light and Power Company, Louisville, Ky., has been attached.

—— The electric light company was one of the heaviest losers by the recent fire at Creede, Colo.

—— The electric light and gas plants at Marshall, Tex., have been sold under execution for $4,610.

—— The Edison Electric Light Company, of Salida, Colo., has increased its capital stock from $30,000 to $50,000.

—— The North River Electric Light and Power Co., of New York, has increased its capital stock from $200,000 to $400,000.

—— The taxpayers of Lansing, Mich., will vote on June 29 on a proposition to bond the city for $60,000 for the purchase of an electric lighting plant.

—— The commissioners of the District of Columbia recently gave notice that all the theatres of Washington must be fitted throughout with electric lights.

—— The law committee of the Albany, N. Y., Board of Trustees has been granted further time to ascertain the probable cost of establishing a corporation electric light plant.

—— Northwest Thomson-Houston Company stockholders held a special meeting June 15 to change the name to Northwest General Electric Company and increase the common capital stock from $750,000 to $1,000,000.

—— The Edison Electric Illuminating Company, of Boston, is now paying five per cent. per annum instead of four. It earned six per cent. last year, and is now said to be earning eight. The stock has advanced ten points in six weeks.

—— The Westinghouse Electric and Manufacturing Company has declared a semi-annual dividend of 3½ per cent. on the preferred stock, payable July 1 to stockholders of record June 20. Books close June 20 and re-open July 2.

—— The Wolverine Electric Light Company, of Holland, Mich., has served an injunction on the common council to prohibit them from putting in an electric light plant for the city. The company claim that the election which decided the matter to put in a city plant was not legal and hence they mean to fight it.

—— The ELECTRICAL REVIEW acknowledges an invitation to attend the Eighth Annual Exhibition and Graduation Exercises of the Pupils of the Hebrew Technical Institute, of this city, which were held June 16. Dr. Otto A. Moses, widely known in electrical circles, is director of the Institute, which is meeting with excellent success.

—— The judges of the three Courts of Common Pleas, of Pittsburgh, recently met to ratify the action of the commissioners relative to the erection of a building on the site of the old criminal court building for a lighting and heating plant for the courthouse and jail. The structure will cost from $150,000 to $170,000. Judges Slagle and Ewing were absent. Those present approved the plan.

—— The specifications for the extension of the Elgin, Ill., city electric light plant were so prepared as to invite bids only from low tension men. It shut others out. This being the case at a recent council meeting, several bids were returned unopened to representatives of electric companies who were present. Proposals will again be advertised for and bids from all classes of manufacturers will be invited.

KINDRED INTERESTS

Day's Kerite is endorsed after 18 years' use by the inspector of electric light wires at Ottawa, Can. His letter appears on another page.

Riehle Brothers Testing Machine Company, of Philadelphia, whose New York office is at 93 Liberty street, have issued an illustrated pamphlet describing their testing machines for all purposes.

J. Elliott Shaw & Company, 632 Arch street, Philadelphia, manufacturers of the celebrated Norway iron frame electric bell, have issued a very complete catalogue and price list of electrical supplies which they carry in stock.

"Goulds' Efficient Power Pumps and Their Applications" is the title of a noteworthy catalogue sent out by the Goulds' Manufacturing Company, of Seneca Falls, N. Y. Every manner of service is afforded by the Goulds' triplex and electric pumps. The illustrations in this catalogue are really works of art.

The Eppinger & Russell Creosoting Works, whose New York office is at 160 Water street, have issued an interesting illustrated pamphlet describing their method of creosoting piles and timbers for all purposes by the dead oil of tar process. Those interested in the subject would do well to secure a copy of this pamphlet, which may be obtained by addressing as above.

The Central Electric Company, Chicago, are putting on the market a very compact little fan motor, made in sizes, one-sixth, one-eighth and one-quarter horse-power. These motors can be used on desks, and can be attached to the wall by a simple device, the whole being the product of the Interior Conduit and Insulation Company, for which the Central Electric Company are general Western agents. The price asked is a modest one, and they should command a ready sale.

New Jersey Lamp and Bronze Works, of New Brunswick, N. J., has organized a manufactory for electric and gas chandeliers, brackets and electric fittings in brass and copper. The machinery, tools and dies are ready, and by Autumn a handsome line of goods will be placed on the market. Mr. G. Wilfred Pearce, railway and electrical editor of *Dixie*, of Atlanta, Ga., who is an artistic designer and practical fixture maker, has been especially engaged to organize this department. Several hundred hands will be employed. The company has established offices in New York city, at 44 Murray street.

The Railway Equipment Company, Chicago, reports for the last week orders for the complete equipment of roads in New Haven, Conn.; Brooklyn, N. Y.; Baltimore, Md.; Evansville, Ind.; Chillicothe, O.; Pittsburgh, Pa.; Hamilton, Can.; Augusta, Ga.; Kokomo, Ind., and Put-in-Bay, O. They have also made during the same time large sales for extensions of present roads. The business of this company is constantly increasing. The standard material of their manufacture is known to be reliable and their facilities for promptly filling orders are unequalled.

Samuel F. Hodge & Company, of Detroit, Mich., have adopted the plans of the Berlin Iron Bridge Company, of East Berlin, Conn., for their new foundry, and have placed the contract with the Berlin Company for the construction of the building. It is expected that this will be the most perfect and best appointed foundry in the Northwest. The general dimensions of the building are 86 feet in width by 161 feet in length. On each side there is a wing 23 feet in width. The center of the building is controlled by a traveling crane with a travel the full length of the building. The wings of the building are controlled by jib cranes, so that when completed every inch of the floor surface will be controlled by power, either from the traveling crane or from the jib cranes. The construction will be entirely of brick and iron.

The "C. & C." Electric Motor Company, New York, is one of the progressive concerns of the electrical field. This is evidenced in their new general catalogue for 1892, which has just appeared. It is more elaborate than any of their previous catalogues, as it includes not only a list of "C. & C." motors and dynamos, but also a careful description of all the supplies necessary for the complete equipment of electric light and power plants. The company has sold a large number of their standard generators during the past few months, and this department of their business is rapidly attaining equal importance with that of their regular line of motors. The other specialties of note in the new catalogue are several new switches, an automatic motor starting box, an organ rheostat and organ attachment, and fans, blowers and other ventilating machines.

Massachusetts Institute of Technology.

Entrance examinations for the Massachusetts Institute of Technology, of Boston, will be held at the Institute and in all the large cities of the country. Those in New York will be held on June 30 and July 1 at the Fifth Avenue Hotel, in charge of a member of the faculty. To be admitted as a regular student in the first-year class of the school of industrial science, the applicant must have attained the age of 17 years, and must pass a satisfactory examination in arithmetic, algebra, plain geometry, French (or German), English, history and geography.

TREASURY DEPARTMENT, WASHINGTON, D. C., June 6, 1892.—Sealed proposals will be received at this Department until 2 o'clock, P.M., Monday, June 27, 1892, for furnishing electrical supplies required during the fiscal year ending June 30, 1893, for U.S. buildings at Pittsburgh and Philadelphia, Pa.; Cincinnati, Ohio, Boston, Mass.; Chicago, Ill.; St. Louis and Kansas City, Mo.; New Orleans, La., and Baltimore, Md. Instructions to bidders will be furnished on application. Proposals must state price per unit. The Department reserves the right to two annual renewals of accepted proposals, and to reject any or all bids or parts of bids, and to waive defects. Proposals must be addressed to the Secretary of the Treasury, Washington, D. C., and marked, "Proposals for Electrical Supplies."
CHARLES FOSTER, Secretary.

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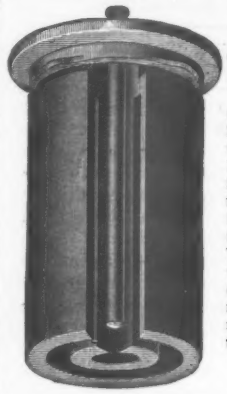

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